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PROCEEDINGS

TENTH ANNUAL CONVENTION

Smoke Prevention Association

Cincinnati, Ohio
September 8-10, 1915

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Air Pollution Control Association

PROCEEDINGS

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TENTH ANNUAL CONVENTION
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OFFICERS

Smoke Prevention Association

1915-1916

President,

WILLIAM A. HOFFMAN,
St. Louis, Mo.

Vice-President,

CHARLES W. HEATH,
Cincinnati, O.

Secretary-Treasurer,

FRANK A. CHAMBERS,
608 City Hall, Chicago, Ill.

Standardization Committee.

MARTIN A. ROONEY, M. E., Chairman	Nashville, Tenn.
LOUIS C. TOWNER	Grand Rapids, Mich.
JOHN J. O'CONNOR, JR.	Pittsburg, Pa.
WILLIAM A. HOFFMAN	St. Louis, Mo.
W. E. PORTER	Pittsburg, Pa.
FRANK A. CHAMBERS	Chicago, Ill.
J. H. LEWIS	Chicago, Ill.
CHAS. W. HEATH	Cincinnati, O.
W. A. PITTSFORD	Chicago, Ill.
CHAS. H. BROMLEY	New York City.
O. MONNETT	Chicago, Ill.

The Eleventh Annual Convention will be held at St. Louis, Mo., September 26-29, 1916.

MR. WM. A. HOFFMAN,
President,
St. Louis, Mo.

MR. FRANK A. CHAMBERS,
Secretary-Treasurer,
Chicago, Ill.

MR. CHAS. W. HEATH,
Vice-President,
Cincinnati, Ohio.

Proceedings Tenth Annual Convention Smoke Prevention Association

The Tenth Annual Convention of the Smoke Prevention Association for the Prevention of Smoke was held at Cincinnati, Ohio, at the Hotel Sinton, on September 8, 9 and 10, 1915, under the presidency of Louis C. Towner, Grand Rapids, Michigan; Mr. S. H. Viall, officiating as Secretary.

FIRST SESSION—WEDNESDAY MORNING, SEPTEMBER 8, 1915.

The Convention was called to order at ten o'clock A. M. on Wednesday, September 8, 1915, by President Towner, who said:

Ladies and Gentlemen, it gives me great pleasure this morning to welcome each and every member at the opening session of this Convention; and in order that we may proceed very rapidly with our program, which is quite an extensive one, and is surely the best program that we have ever had, I will introduce without further ceremony at this time, Hon. Frederick S. Spiegel, Mayor of Cincinnati, who will deliver an address of welcome.

ADDRESS OF WELCOME—HON. FEREDICK S. SPIEGEL, MAYOR.

Gentlemen of the Convention:

I am pleased as Mayor of the city to give you a cordial welcome on behalf of our people, because you represent one of the most useful phases of modern municipal activity—that of elimination of smoke. This is a subject of comparatively recent endeavor. It is not long since when our greatest cities pointed with pride, as it were, to the fact that their factories and other sources of smoke emission, were so busy that the atmosphere above them was composed in the larger part of smoke. The spirit of those times had not put into practical use the thought that our flat buildings, our great manufactories, and even our railroads can be conducted without seriously contaminating the atmosphere.

Therefore, you represent a modern thought, a new thought, a thought so useful and so prolific of good for all concerned, that we are prone to stop awhile in our progress and wonder why the campaigns for smoke elimination were not initiated long ago. It may be that the development of mechanical devices during the past few years has made it possible for our cities to enjoy comparative freedom from smoke. But, it is true, nevertheless, that the active, the vigilant, the systematic and the insistent fights for free, pure air, day and night, over and about our cities, is a comparatively recent innovation.

I want to publicly express my appreciation of the work accomplished by our Smoke Inspection Department under the administration of Mr. Heath. He and his men are entitled to a great deal of credit for the results thus far accomplished here. And, I am pleased to add that the spirit of antagonism which formerly prevailed against the Smoke Inspector and his men, has been eliminated, in fact so happily disposed of, that now he is finding friendly co-operation where formerly a feeling of enmity was manifested. Our men of large business affairs and the railroads are enlisted in the cause of smoke elimination.

Therefore, I feel justified in the prophecy that it is only a matter of time until the ambitions of the administration will be realized, and that in so far as practical results are concerned Cincinnati will be a smokeless city. But, there remains a great deal to be done. New devices are to be installed. New measures must be written, and there must be a still wider range of co-operation before the hopes of our citizens that Cincinnati is a city without smoke, shall be realized. Therefore, we are glad to have you with us.

I understand you represent the foremost steps that have been taken in the cities of this and other countries for the clearing of the air, day and night, year in and year out, for our great municipalities. The Smoke Inspection Department is classified in value with the Health Officer, the Building Commissioner and others in compelling conditions of complete sanitation. We are learning to provide additional comforts, additional conveniences, better living quarters and cleaner air. The results of complete sanitary inspection is one of the greatest achievements of a modern city. The Department of Smoke Inspection is one of the most important factors to that end.

We feel that we have the best smoke ordinance in the world. There went into effect a few days ago an ordinance requiring the installation of a smokeless type of heating boiler or hot air furnace in all new buildings, excepting those to be used as a dwelling-place for fewer than five (5) families. This new law will aid materially in completing the work of smoke elimination thus far advanced. The large manufacturers have pledged themselves to smoke elimination. The railway officials have done likewise. Now we have taken care of the large apartment buildings.

I believe in the genius of American invention. I believe the time is not distant when every dwelling-house, however small, will be provided with a smoke destroying device, which will be within the reach of every household, and when that is accomplished then we can stop, take our breath, survey the field and take care of that which may have escaped our notice as we move along the line. With smoke elimination there will come the desire to further beautify our buildings. The presence of smoke to a considerable degree over the city with its attendant destructive effects had a tendency to discourage our desire to beautify and ornament our public and private dwellings. We have found it almost impossible to grow trees and shrubbery within the busy parts of the city, because of the atmosphere being heavily laden with the output of innumerable chimneys..

But, happily, all this is passing. There is no reason why, with a Smoke Inspection Department in complete control of matters within its authority, with an administration, the energy of which is impelled by a friendly desire to help the citizens and clean up at the same time that we should not be free from smoke. Therefore, there is no reason, I repeat, why all parts of the city should not be made more attractive. We are learning to pave our streets in an attractive as well as a substantial manner. And this work goes hand in hand with the equally important one of providing our people with an atmosphere as clean as modern methods can provide.

We are having the co-operation of the authorities of our sister cities, which are situated just across the river in the State of Kentucky. Their aid in this work is necessary, because unless they clean up we will get their smoke with the wind that comes from the south. The Mayors of these cities are a part of your Convention, and I believe you will find that they are as greatly interested in this work as I am. The administration is fortunate in having the assistance of the members of what we know as the United Smoke Committees of Cincinnati. This body is made of the members of the Smoke Abatement Committees of many of our civic organizations. The work of that joint body has been of inestimable value to our Smoke Inspector. He has had their assistance in the work of investigation, to the end that the smoke ordinances shall be fair, that no injustice, however small, shall be done to any person or number of people in whatsoever interest they may have in the matter of our attempts to eliminate smoke. This is a very important matter. It is good to know that when an important bit of legislation is written providing for a work of reform or advancement, that it is fair to everybody alike.

I believe that the program which has been prepared, gives opportunity for you to view our city from the hilltops. Certainly you will visit the top of the Union Central Life Insurance Building, where is maintained the department of surveillance, which enables the inspector to keep in touch with actual smoke conditions, not only in the city but within a territory extending many miles in all directions. I speak of this, because you will have exceptional opportunities to see for yourself what has been accomplished here in this line of work.

I would have you remember during these trips of inspection that Cincinnati is a great manufacturing city. Our industries are not only large, but varied in character. Almost every one of them calls for the use of plants which ordinarily give out dense clouds of smoke. The fact that you can see every part of the city from the hilltops almost every day in the year, is ample proof that we have made large progress in solving the problem for a practical, definite and unending clearing of our atmosphere of soot and smoke. Our people will learn with great interest of the work of your Convention. We know you are here for our good as well as the good of your own people, and therefore, on their behalf I take pleasure in extending you the keys of the city together with an expression of the hope that your stay here shall be pleasant and profitable, and that you may have occasion in the future to refer to Cincinnati as a place that has done as much as any other city toward the successful solution of the old problem of the smoke nuisance.

PRESIDENT TOWNER: In addition to the hearty welcome which has been extended to us by his Honor, the Mayor, we are to have a welcome address on behalf of the United Smoke Committees of Cincinnati and Smoke Elimination Committee of the Chamber of Commerce by Mr. William F. Ray, President of the United Smoke Committee. (Applause.)

ADDRESS OF WELCOME ON BEHALF OF THE UNITED SMOKE COMMITTEES OF CINCINNATI AND THE SMOKE ELIMINATION COMMITTEE OF THE CHAMBER OF COMMERCE.

BY WILLIAM F. RAY, PRESIDENT.

MY FRIENDS: You have been invited by your Cincinnati representative, Mr. Heath, for whom I had the greatest respect until he insisted upon putting my name on the first page of the programme, and by the Cincinnati Chamber of Commerce, to hold your deliberations in Cincinnati at this time.

You have been given a hearty welcome by the chief executive of our city, the Honorable Mayor, Judge Frederick S. Spiegel.

If there was anything that I could say that would make you feel more at home or that would help you in your discussions and problems, I assure you that it would be the greatest pleasure in the world for me to say the word.

Picture yourself, as it were, on a visit to a friendly neighbor, and having comfortably planted yourself in the easy chair listening to the words of welcome flowing from the lips of your host, further conversation is interrupted by the in-rush of the household who gather around the chair of the host, and cast admiring and inquiring glances in your direction. Their friendships won, their sturdy faces beam their welcome. You felt you were welcome before, you see that welcome now all pouring out in smiling looks of the youthful household.

And such, my friends, is the position of the various Committees which make up the household, and which is called the United Smoke Committees.

The United Smoke Committees of Cincinnati were formed seven years ago, in the fall of the year 1908.

Professor John T. Faig was then Chairman of the Smoke Prevention Committees of two civic organizations. Professor Faig suggested as I was also Chairman of two Smoke Prevention Committees that by forming a joint committee we could prevent much duplication of effort, and by working in harmony be more effective.

At our first meeting we had representatives from seven different organizations, and after seven years' work have eleven of the leading organizations working together and in harmony. Our frequent boast is that while our constitution provides for annual dues of $10.00, we have not called for the second year's dues, and have money in the treasury.

The purpose of the United Smoke Committees is to collect, edit and distribute scientific information on smoke abatement, and to otherwise assist in furthering the cause in Cincinnati and vicinity by such means as shall from time to time be determined upon.

That the dream of power behind such a combination came true is evidenced by the progress of the cause. The United Committees, working along the line of education and having amongst its delegates practical engineers, were drawn into a movement to prepare a Code for use of the city authorities. A public meeting was held, and the Mayor appointed a Committee of Three to draft a Code.

A majority of the committee were members of the United Committees, and our members helped in getting the Code passed by the City Council. Quite recently our Committees aided Mr. Heath, the Smoke

Inspector, in getting additional regulations placed in the Code, and we point with pride to an ordinance that can well be copied by other cities.

Members of our Committees have assisted in the Civil Service examination for the position of Smoke Inspectors, and have ever been ready to aid in the prevention of smoke, but not in the prosecution of offenders. So careful are the United Committees of our principles that we will not allow the Smoke Abatement League, of which I am a Trustee, to become a member of the organization of which I am the President.

The United Committees now is composed of delegates from eleven organizations—Business Men's Club, City Club, Federated Improvement Association, Engineers' Club, American Chemical Society, American Institute Architects, Academy of Medicine, N. A. S. E. No. 15, National Association Stationary Engineers No. 36, International Union Steam and Op. Eng. No. 18, Chamber of Commerce.

Our city is situated very peculiarly, in that our hills prevent the rapid dissemination of the smoke from the basin of the city, but conditions have much improved in the past few years, and we intend that they shall keep on getting better.

We have added what little assistance we can to the efforts of your local member, Mr. Charles W. Heath, to make your Convention a success—because we like him. We want you to have a successful Convention. We want you to feel at home in this good old town, of which we are proud and which we delight in calling the Queen City of the West.

We want you to enjoy yourselves in the short space of time that you can spare from the business sessions, and we want you to look forward to a speedy return to our city.

PRESIDENT TOWNER: Gentlemen, we will now have an address of welcome on behalf of the Cincinnati Smoke Abatement League. This address was to have been given by Mr. Louis T. More, President of the League, but Mr. More being unable to be present, is represented by Mr. Edward F. Jerome, who is the Superintendent of the Smoke Abatement League of Cincinnati, and who will extend a welcome as representing Mr. More.

ADDRESS OF WELCOME ON BEHALF OF CINCINNATI SMOKE ABATEMENT LEAGUE.

BY EDWARD F. JEROME, SUPT.

Mr. President, Mr. Mayor, Ladies and Gentlemen:

As you will see by the program, Professor More of the University of Cincinnati was to deliver an address of welcome, he being President of the Cincinnati Smoke Abatement League. His absence in northern

New York makes his attendance here impossible this morning. We expected to secure several other speakers to take his place who are well known in this community, but were unsuccessful because of their absence from the city, and it was only ten minutes ago I learned that this duty was to fall upon the speaker. I would not perpetrate a pun, and certainly not a bad one, but it seems to me that the Smoke Abatement forces have come back to their native heath.

Twenty-five years ago Cincinnati was the first city in the country, with exception of Chicago, to pass an anti-smoke ordinance. You may not have run across that fact in your reading, but that is the fact in the case; so it is preeminently fitting and proper from our standpoint that you meet here today.

There are some cities in the country, for instance New York City, that, so far as I am advised, have no smoke ordinance; but, regardless of that, the smoke nuisance is controlled in such cities by their Boards of Health. The damage done by smoke may well come under the province of the Health Department.

We are thoroughly glad to see you gentlemen this morning, coming here from the north, the south, the east, the west, and we want you to enjoy yourselves here. Cincinnati is the home of good cheer, and, as you know, the half-way house between the North and the South, and it partakes to a large degree of the characteristics of both sections. There was a time when we in the north, and our brothers in the south, were arrayed against each other; today we are arrayed against one common enemy—smoke—and I rejoice and congratulate you all that we are co-operating in such a glorious cause.

For myself personally I am proud to stand here as representative of the Cincinnati Smoke Abatement League, which has for ten long years stood for this idea. You know that every man in the world has to have some central thought or idea to give him a purpose in life, otherwise his existence would be a blank. In the old days before the war, there were certain people in the north who thought that slavery should be abolished, and to that end they organized and worked, and we all know the result.

Now in these days, we are also working against slavery of another form, slavery to smoke, which is what we must combat with all our force and end. To that end we must ignore all past differences or any party lines and unite in one common cause.

Permit me, as the official representative of the Cincinnati Smoke Abatement League, to extend to you a heartfelt welcome to Cincinnati. May your stay here be most pleasant and fruitful in good results, and you may feel assured that we will be glad to welcome you any time when you can return.

RESPONSE TO ADDRESSES OF WELCOME BY PRESIDENT LOUIS C. TOWNER.

Gentlemen of the Convention and Citizens of Cincinnati:

This is one of the times of my life that I am placed in what is to me a very embarrassing position—being called to respond to such cordial and hearty addresses of welcome as we have had from the distinguished gentlemen who have preceded me. It places a common ordinary man like myself in a very embarrassing position; but I wish to say here that I believe that smoke elimination is the greatest single movement that the world has undertaken up to this time for the advancement of human happiness and health because I believe that when, through the efforts of smoke inspectors and smoke departments of the different cities, we succeed in clearing the atmosphere of smoke and dirt, we will have no need of Boards of Health and no need of other departments that now are necessary.

All will acknowledge that taking into consideration the great progress that is now being made toward smoke elimination, that certain things will necessarily be eliminated and the general welfare of the community at large will be largely conserved.

Smoke is a most damaging element not only physically and materially but morally. It destroys greatly the value of property, it is an impairment to health, and in many ways a great disadvantage to any city or community.

We warmly appreciate the address of welcome that has been extended to us on behalf of the United Smoke Committees of Cincinnati by Mr. Ray, on behalf of the Cincinnati Smoke Abatement League by Mr. Jerome, and the very able and elaborate address by his Honor, Mayor Spiegel.

I wish to assure these gentlemen that this Association will go away from Cincinnati after having enjoyed the happiest time that they have ever had in their lives. I want to assure his Honor, the Mayor, and these other gentlemen, that he may be sure that the reputation for Cincinnati for hospitality will not suffer when we reach our homes, because we will have much to tell of our very hospitable reception and entertainment here. I know that our delegates will derive much benefit from their visit to Cincinnati.

If the present speaker were more gifted in an oratorical way, this response would be longer, but your humble President will now proceed with the regular order of business.

The first in order is the reading of Minutes of the 1914 Convention by Secretary S. H. Viall of Chicago.

Secretary Viall read the Minutes of the last Convention, held at

Grand Rapids, Mich., on September 9, 10 and 11, 1914, which, without objection, were approved as read.

PRESIDENT TOWNER: The next order of business is reports of Committees. I would like to first appoint at this time the Auditing Committee, viz.: C. R. Brunelle, Chicago, Ill.; George W. Snow, Salt Lake City, Utah; Warren A. Edson, Boston, Mass.

We will listen to the report of the Committee on Publicity. Is there any report from that Committee?

O. MONNETT, Chicago, Ill.: The Secretary has some notes of the work done by the Publicity Committee which I will ask him to read.

SECRETARY VIALL: I neglected to bring that material along, and in the meantime would ask that you go ahead with some other business and I will have it here in a few minutes.

The Chair called for the Report of the Committee on Standardization.

Mr. Martin A. Rooney, Smoke Inspector, Nashville, Tenn., one of the Members of the Committee, read the Report, and also following it a Supplemental Report, both of which are set out below:

REPORT OF STANDARDIZATION COMMITTEE.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.

CINCINNATI, O., SEPT. 8, 1915.

Standardization of methods, practices and apparatus is undoubtedly the most important work that can be performed by this organization. Our avowed object is to clear the atmosphere of our cities of the smoke nuisance by the employment of proper apparatus and methods for the combustion of fuel and, therefore, it is our privilege and our duty to determine by our experience the best practice and to declare to the public what this best practice is.

Standardization is important to the individual smoke inspector because uniform practice will supply a standard for measuring the results obtained by any individual as compared with the work of others and because requirements backed up by the authority of such an organization as this will be much more easily enforced.

It is of the utmost importance and will be highly appreciated by the great body of manufacturers, engineers and contractors, for it will save them an immense amount of time now spent in correspondence and inquiry to ascertain the practice of each department and will result in a great saving of time in drafting and designing and enable them to avoid much useless duplication of patterns and tools.

To the public that pays the bills, standardization should result in more efficient service at less cost, lower cost for equipment and better fuel economy; the work of smoke elimination will progress faster, and probably more important than all they will be protected from the great horde of fakirs who now prey on their credulity and ignorance.

Your committee recommends to you the following plan of proceeding with this work:

Give the president of this organization or the chairman of the standardization committee the power to appoint a large and carefully selected committee. Assign to each member of this committee some phase of the work with which he is particularly well acquainted. Let each committeeman gather all the data and information necessary concerning his subject, draw his conclusions and submit to the chairman of the committee, who, in turn, will submit it to the whole committee which, by letter ballot, can decide whether or not it shall be submitted to the association. The committee will thus formulate a standard (or rather a recommended standard). The practice decided on can then be submitted to the members of this organization and to all others interested in this work and by them put in practice until the next annual meeting at which time the association can either adopt or reject the recommended standards.

The work of this committee should be prosecuted in a systematic and business-like manner. All reports of recommended standards to members should be made on some standard size sheet so punched and indexed that on the final adoption of the standards each member of the association will have a hand book, one page of which will deal with some particular subject and the whole of which will be a complete volume on smoke prevention and furnace design. If practicable, some mnemonic system of numbering these sheets should be observed.

By following this plan each phase of the work is carried on by an expert in his line, his findings are passed on by a committee of experts each of whom will view them in relation to his own phase of the work and it is finally subject to the test of actual use and to the criticism of all the members of the association before final adoption. By following this plan the work can be prosecuted with dispatch and by our next annual meeting a considerable part of our standardization work will have been accomplished.

In starting on this work we must bear in mind that though these standards are adopted by this organization that no member is in any way obligated to use them in his practice and that the standards adopted must in no way hinder the development of the art and that no standard must be adopted except where uniformity of practice will be beneficial. We must also remember that we cannot carry on such a great amount of work as this without the hearty co-operation of other societies and of the manufacturers.

We submit to you the following list of subjects which we believe are susceptible of standardization and the items which we believe could be standardized.

(1) Ordinances.
  (a) Definition of dense smoke.
  (b) Definition of violation.
  (c) Permit clause.
  (d) Certificate of operation clause.

It may be possible to draw up several standard ordinances to suit different conditions.

(2) Office methods, forms, etc.

If it were possible to work under standard ordinances it would follow that a great many of our forms, methods, etc., could be made uniform, but at present it seems that the following methods could be standardized.
  (a) Method of taking draft readings.
  (b) Firing instructions for at least some classes of furnaces.
  (c) Methods of procedure in regard to application for permits.
  And the following forms—
  (d) Applications for permits.
  (e) Blanks for taking stack readings.
  (f) Permit.
  (g) Certificate of operation.

(3) Reading stacks.
  (a) Chart for grading smoke.
  (b) Method of reading stacks.
  (c) Method of figuring smoke density.

(4) Stacks.
  (a) Sizes or size increments.
  (b) Rule as to projection above roofs.
  (c) Formulæ for calculating area and height.
  (d) Tables of stack sizes for various sizes and classes of furnaces.

(5) Breechings.
  (a) Formulæ for calculating area.
  (b) Formulæ for calculating loss of draft due to length, bends, restrictions, dips, etc.
  (c) Rules for proportions and shape.
  Possibly rules for dampers could be included under this head.

(6) Fire box heating boilers.
  (a) Rules for use of down draft grates.
  (b) Rules for maximum and minimum size to be used.
  (c) Rules for breechings and possibly standard smoke collars.
  (d) Rules for stack sizes.
(7) Horizontal return tubular boilers. For all furnaces.
  (a) Depth of combustion chamber.
  (b) Back space.
  (c) Front space.
  (d) Dampers.
  (e) Size, position, etc., of clean-out doors.
  (f) Specifications for back arch construction.
  For hand-fired furnaces only:
  (h) Slope of grates.
  (i) Proportion of grate surface to heating surface.
  (j) Distance from dead plate to shell.
(8) Small vertical fire tube boilers.
  (a) Maximum and minimum sizes and numbers.
  (b) Stacks, breechings, etc.
  (c) Fuel.
(9) Locomotive type. Economic and other fire box types.
  (a) Maximum and minimum sizes and numbers.
  (b) Stacks and breechings.
  (c) Fuel.
(10) Hot air furnaces.
  (a) Maximum and minimum sizes and numbers.
  (b) Stacks and breechings.
  (c) Fuel.

Standard settings should be established for each type of furnace or stoker and for every combination of furnaces and boilers. For each of these furnaces the following points should be standardized:

(I) Maximum and minimum ratio of grate surface to heating surface.
(II) Maximum and minimum grate area or number and size of retorts in one furnace.
(III) Maximum and minimum grate area or number and size of retorts in one plant or on one stack.
(IV) Maximum and minimum ratio of combustion for various fuels.
(V) Maximum and minimum draft in furnace.
(VI) With what boilers or for what purposes allowed and not allowed.

(VII) With what fuels allowed and not allowed.
(VIII) Requirements for installation with each type and size of boiler.
(IX) Distance to heating surface.
(X) Length, arrangement, etc., of arches.
(XI) A drawing giving dimensions for standard settings with various types of furnaces could be furnished.
  (11) Plain grates.
  (12) Air admission devices.
  (13) Steam jets.
  (14) Wing wall.
  (15) Double arch bridge wall.
  (16) Dutch oven.
  (17) Burke type.
  (18) McMillian type.
  (19) Semi-automatic types.
  (20) Down draft.
    Stokers.
  (21) Front feed.
  (22) Side feed.
  (23) Chain grates.
  (24) Underfeed.
  (25) Locomotives.
    Roundhouse practice.
    Firing.
    Blowers.
    Arches.
    Air admission devices.
    Jets.

We submit this plan to you hoping that it will meet with your approval, and should it meet with your favor, we bespeak for it the support and assistance of every member of the association.

Respectfully submitted,
COMMITTEE ON STANDARDIZATION.
MARTIN A. ROONEY, Chairman.
FRANK A. CHAMBERS.
CHAS. W. HEATH.

METHOD FOR RECORDING SMOKE PERFORMANCE OF CHIMNEYS.

A SUGGESTION BY S. H. VIALL TO THE STANDARDIZATION COMMITTEE OF THE INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.
MARTIN A. ROONEY, CHAIRMAN. AUGUST 16, 1915.

Smoke ordinances of different cities vary to such an extent that a smoke performance which may comply with the terms of the law in one place would constitute a violation in some other community.

Practically all smoke ordinances forbid the emission of smoke of a prescribed density, except for specified periods when fires are being cleaned or being built. It is possible, under these laws, for a chimney to continuously emit smoke that is a slight degree lighter than the prescribed shade and yet not violate the legal limitations.

Chimneys that emit considerable visible smoke, even though they may not exactly violate the provisions of a given regulation, are considered unsatisfactory, both by smoke authorities and the public.

Furnace manufacturers, promoters of smoke abatement devices, and allied equipment find that the authorities of the different cities vary in their conclusions as to what is satisfactory smoke abatement. There is need of a uniformly accepted standard to use in determining whether or not a given furnace, smoke abatement apparatus or chimney is, on the average, satisfactory in abating visible smoke.

Your committee recommends that a chimney, furnace or smoke abatement apparatus, to be considered satisfactory, must not violate the terms of the smoke ordinance nor emit smoke of an average density greater or darker than 5 per cent.

Your committee recommends that the system for determining the average percentage of smoke density, as defined and described in this report, be adopted and used as a means of recording and communicating information relative to the visible smoke produced by a given furnace, smoke abatement apparatus or chimney. Persons familiar with the system, knowing the smoke regulations of a given locality, and having a record, as is herein recommended, of the performance of a given furnace, smoke abatement apparatus, or chimney, will be able to determine how a furnace, or apparatus served by a chimney smoking as shown by the records, would be received in the locality considered. The records recommended would furnish a means of comparing the visible smoke production of two or more chimneys, furnaces, or sets of apparatus, even though the equipment compared were located in different parts of the country.

Your committee recommends that the Ringelmann chart, or proportional reproductions thereof, as issued by the U. S. Geological Survey, be used as a gauge to compare or estimate the instantaneous smoke density of a chimney, furnace or apparatus.

The Ringelmann chart has been selected as a gauge for estimating the density of smoke because it is widely available and generally known. Observations should be made for ten hours, or more, in order to determine an average. A ten-hour period reduces the effect of possible error, either in the chart used or on the part of the personal element, to a minimum, and to a negligible quantity if the observations are made with conscientious accuracy. Besides reducing the effect of any error, a ten-hour period will include many of the fluctuations or changes in conditions that are usually found in the operation of furnaces, smoke abatement apparatus or chimneys, under normal working conditions.

Unless otherwise definitely stated, it is to be understood, when percentage density figures are quoted, that the figures are an average and that conditions of operation were normal in every respect at the time the observations were made.

THE RINGELMANN CHART.

The Ringelmann chart provides for designating the density of smoke by a number, as follows:

No smoke	Number	0
Light gray smoke	"	1
Darker gray smoke	"	2
Very dark gray smoke	"	3
Black smoke	"	4
Very thick black smoke	"	5

The base or standard for determining the shade corresponding to the above numbers consists of a set of charts, each fourteen centimeters by twenty-one centimeters (the cards on which the charts are produced are of larger size), made up of black lines drawn at right angles vertically and horizontally upon white paper. The width of the black lines and the size of the white squares formed are given in the following table

Number of Scale	Side of White Squares in Millimeters	Thickness of Black Lines in Millimeters
0	rectangle all white	
1	8.94	1.06
2	7.75	2.25
3	6.32	3.68
4	4.47	5.53
5	rectangle all black	

When making observations, the chart, or proportional reproductions of it, shall be placed in a vertical position at such a distance from the observer that the charts appear as even shades of coloring, ranging from light gray for number 1 to almost black (not totally black) for number 4.

The charts are so proportioned that the width of the black lines covers respectively 0, 20, 40, 60, 80 and 100 per cent of the white surface of rectangles. By use of the charts an observer can readily estimate the shades of smoke as follows:

Chart Number	Percentage of Light Prevented From Passing Across Top of Stack	Percentage of Light Allowed to Pass Across Top of Stack
0	0	100
1	20	80
2	40	60
3	60	40
4	80	20
5	100	0

METHODS OF MAKING OBSERVATIONS.

The observer shall take a position so that the direction of observation is practically at right angles to the travel of the smoke.

The chart shall be so placed as to facilitate comparison with the density of the smoke.

Observations must be made of the smoke just as it proceeds from the top of the stack, from a point as near on a level with the top of the stack as is convenient, and at least 100 feet but not more than one-fourth mile from the stack.

The background immediately beyond the top of the stack should be free, so far as possible, of buildings or other large dark objects.

The observer should avoid looking toward bright sunlight.

The observer shall determine which shade on the chart most nearly corresponds to the shade of the smoke emitted, at a given time, and then shall record the corresponding number upon a suitable form.

Record of observations shall be made at 15-second intervals for at least 60 consecutive minutes without interruption. Ten hours of such observations will be sufficient to determine the average smoke density of a given equipment for a given method of operation.

A convenient form to use for recording observations of smoke emissions is to arrange a number of vertical columns upon a page, each column to be divided vertically into four sub-columns. Paralleling the main columns and corresponding with horizontal lines crossing the main columns, place numbers 0, 1, 2, 3, etc., up to and including 59. The results of observations at 15-second intervals can be recorded as follows:

Observations made on the even minute enter in the first sub-column.

Observations made on the quarter minute enter in the second sub-column.

Observations made on the half minute enter in the third sub-column.

Observations made on the three-quarters minute enter in the fourth sub-column.

Enter the chart number for the shade or density that most nearly corresponds to the shade or density of the smoke, at the time of a given observation, opposite the number corresponding to the number of minutes of the hour that have elapsed.

COMPUTING PERCENTAGE DENSITY.

To make the calculations for average percentage density for any hour, add together the several numbers (0, 1, 2, 3, 4 and 5) entered on the report form for that hour. The sum divided by the number of observations made each minute gives the smoke units.

The formula for computing the percentage density is:

$$\text{Percentage of density equals } \frac{\text{Smoke Units x .20 x 100}}{\text{Stack minutes}}$$

this simplifies to

$$\text{Percentage of density equals } \frac{\text{Smoke Units x 20}}{\text{Stack minutes}}$$

DEFINITIONS.

Percentage of Density of smoke is the percentage of light that is prevented from passing through it. For instance, number one must prevent 20 per cent of light from passing through it, and, on the other hand, must allow 80 per cent of light to pass through it. Number four prevents 80 per cent and passes 20 per cent light; number five is opaque and prevents all light from passing through. Therefore, an average density of 1.37 per cent means that during the time of the observations, the visible smoke prevented 1.37 per cent of the light from passing across the top of the stack, that otherwise would have passed across if it were not for the smoke proceeding from the chimney.

A Smoke Unit corresponds to one minute of number one smoke or its equivalent. For instance, one minute of number two smoke is equivalent to two smoke units; two minutes number three smoke to six smoke units; two and a half minutes of number five smoke to twelve and one-half smoke units, etc.

A Stack Minute corresponds to watching one smoke stack or chimney for one minute. In any set of observations, the stack minutes are obtained by multiplying the number of stacks observed by the number of minutes during which the observations continued.

RECORDS.

Records of Ringelmann observations, besides the tabulation of numbers representing the smoke emitted by a stack should contain the following data:

Direction in which the observer was looking.

Approximate angle made by line of vision and travel of smoke.

Approximate distance observer was from the stack.

Direction from which wind was coming, and approximate velocity.

Character of the weather, that is, bright, clear, cloudy or dull.

The calculated results of the observations should be kept so as to show the density for each hour, and the density for any period of hours. The records should also show the number of minutes of observation and the number minutes of each of the different Ringelmann grades of density; as the number of minutes of numbers 0, 1, 2, 3, 4 and 5, respectively.

Records of percentage density, together with the other data as suggested in the foregoing, will furnish a means for comparing the visible smoke performance of different equipment and permit any one studying the records and familiar with the system to get a clear idea of the smoke conditions at the time the records were made.

That concludes our Report, Mr. Chairman and Gentlemen, and we submit these to you to act upon as you will.

PRESIDENT TOWNER: Gentlemen, what will you do with the Report of the Committee?

PROF. JOHN J. O'CONNOR, JR., Univ. of Pittsburgh, Pittsburgh: I move, Mr. President, that the first or principal Report of the Committee be adopted.

Motion seconded, carried, and so ordered.

PRESIDENT TOWNER: What will you do with the Supplementary Report of the Committee on Standardization on densities?

E. F. DUBRUL, Cincinnati, Ohio: I move the adoption of the report.

The motion was seconded.

E. F. DUBRUL, Cincinnati, Ohio: I would like to have a little discussion on that. I want to ask what provision the Committee has made to take care of a case like this: Suppose you have a stack too large for the boiler capacity it is drawing from; suppose that the furnaces for those boilers were making a tremendous amount of smoke which would show very dense if it was emitted from a small stack, but by reason of the large size of the stack, the smoke going up is diluted so that it does not come under the percentage of density, as I understand it, that that Committee has standardized. Now, suppose that the standards that the Committee have named were to be applied in that case, should not some provision be made to get at the percentage of dilution, if you want to call it so? I would like to ask Mr. Rooney what the Committee would consider proper along that line?

MARTIN A. ROONEY, Smoke Inspector, Nashville, Tenn.: Well, the density, of course, takes that into account. Density is defined as the degree of solidity, as you might call it. Density means the number of particles of smoke or any other substance, for instance, moisture, as compared with a standard volume in the atmosphere. This report contemplates that you are looking at the smoke just as it is emitted from the top of the stack. Now, the density of the smoke as it comes right out of the top of the stack might be 5 per cent, and a foot or so above the stack it might be four per cent, and a little further on two per cent, and a little further on one per cent, and after a while it would get so that you could not see it at all, its density would be zero, because it would be dissipated in the atmosphere.

E. F. DUBRUL, Cincinnati, Ohio: I understand that, but I am looking at it from the medical or sanitary side of the purification of the atmosphere. Suppose a plant was emitting just as many particles of smoke with a large stack as if the stack were smaller, it would be throwing as much deleterious matter into the atmosphere through a large as through a small stack. Now, that smoke comes out of the top of this stack, and yet it may not fall within the density scale as adopted at that location, that is from its appearance, and yet that smoke may be most deleterious, although it is so diluted that it does not appear objectionable. The mere fact that it is less dense because the stack is larger around and it is more diluted does not prevent it from being damaging to the health of the community. If that same quantity of smoke had been emitted through a small stack measured according to the scale, it would have shown as objectionable.

MARTIN A. ROONEY, Smoke Inspector, Nashville, Tenn.: What you mean is that you have a stack so big that the smoke is spread all out in the air before it gets to the top of the stack. Is that it?

E. F. DUBRUL, Cincinnati, Ohio: That is the point that I want to raise, that with this standard it does not hit that particular condition, and it is a condition that should be reckoned with before the standard is finally adopted.

J. W. HENDERSON, Division Chief, Pittsburgh, Pa.: This rule that they have set up here is a standard that can be applied anywhere, and you can get the actual percentage of density; in other words, you would have the percentage of number one whereas with any ordinary stack you might have had only number four, but the percentage of density would be just as great as this. As I understand this report, the object is to get some rule whereby the reading will be the same in San Francisco as in any other city as to the standard of density.

O. MONNETT, Chicago, Ill.: I have thought a great deal about the density proposition, and in trying to draw up a law that will lay down a line on density, we must not forget the reason for making the density standard. You all know that smoke ordinances prohibit dense smoke, but according to the strict letter of the law, if the stack emits number two smoke, it will get by, although we all know that number two smoke emitted continuously would be a very objectionable performance.

Now we ought to have some standard to measure that objectionable performance and cut it down to the minimum. I think that five per cent would be a proper figure. That is the figure that has been in use in Chicago. You know they use Illinois coal there. In talking with people further East, in Cleveland for instance, I have found that they objected to the five per cent limit on account of the peculiar pumping condition that they get. It seems that the volatile matter of their coal gets away very rapidly in the atmosphere, and that applies to the coal that you get in Ohio and Pennsylvania. They are of the opinion that about seven and a half per cent would be the proper thing. We should be careful in drawing a line not to draw a line, for instance that Chicago could live up to, but that would be practically impossible for Cleveland. I recommend that this question be left open for a time until we find out by actual experience just where that line can be drawn in Ohio and Pennsylvania, but that the main idea of the report be adopted.

PRESIDENT TOWNER: Is there anything further on this?

E. F. DUBRUL, Cincinnati, Ohio: I think Mr. Monnett's point is very well taken. I may have misunderstood the recommendation of the Committee because it is very hard to catch a thing exactly when it is being read; and I would ask whether that recommendation has been distributed to the members

MARTIN A. ROONEY, Smoke Inspector, Nashville, Tenn.: No, sir.

E. F. DUBRUL, Cincinnati, Ohio: I would recommend that the report be distributed to the members in order that they may give it consideration and that action be deferred until the next Convention, after which you will have been able to study the matter in the light of present conditions.

PRESIDENT TOWNER: There is a motion before the house.

PRESIDENT TOWNER: We will now have the report of the Committee on Publicity. I think that our Secretary has that.

PROFESSOR JOHN J. O'CONNOR, JR., University of Pittsburgh: Am I in order to make a motion with regard to the Standardization Committee?

PRESIDENT TOWNER: Yes, we will postpone that other matter for a few minutes and listen to you.

PROF. JOHN J. O'CONNOR, JR., University of Pittsburgh: I move that the President appoint a Standardization Committee, the number to be left to his discretion, which will carry on the work of standardization as contemplated in the report of the Standardization Committee as presented this morning.

Motion seconded, carried, and so ordered.

PRESIDENT TOWNER: I will defer the appointment of that committee until some time tomorrow, and in the meantime will confer with the members.

The next thing in order is the report of the Committee on Publicity, which will be read by the Secretary.

Secretary Viall read the report of the Committee on Publicity.

PRESIDENT TOWNER: Gentlemen, what is your wish in regard to the report of the Committee on Publicity?

On motion, duly seconded, the report was accepted and ordered filed.

PRESIDENT TOWNER: The next in order is the report of the Committee on Ways and Means, Mr. J. W. Henderson, Chairman.

J. W. HENDERSON, Pittsburgh, Pa.: We have formulated a Constitution and By-Laws, and we will ask that our report be deferred until Friday morning. In the meantime copies of the proposed Constitution and By-Laws will be distributed to the membership, so that by that time everyone can vote intelligently.

PRESIDENT TOWNER: Is it your pleasure that the report of the Committee on Ways and Means be postponed untii Friday morning?

SECRETARY VIALL: I move that the report of the Committee on Ways and Means be deferred until Friday morning.

Motion carried, and so ordered.

Mr. C. R. Brunelle, Chairman, presented the report of the Auditing Committee, which on motion was duly accepted.

REPORT OF AUDITING COMMITTEE.

Cincinnati, Ohio, September 8, 1915.

Audited and found balance on hand last audit		$559.47

RECEIPTS.

From dues	$170.00	
From advertising	228.00	
From interest on money in bank	14.78	
Total receipts		412.78
Total to be accounted for		$972.25
Expenditures		482.31
Balance on hand		$489.94

(Signed) George W. Snow,
C. R. Brunelle,
W. A. Edson,
Committee.

SECOND SESSION, WEDNESDAY AFTERNOON, SEPTEMBER 8, 1915.

The convention met pursuant to adjournment, President Towner in the chair.

PRESIDENT TOWNER: We will now take up the papers. The first paper is on "Civic Phases of the Smoke Problem," which will be given by Professor John J. O'Connor, Jr., Mellon Institute of Industrial Research, University of Pittsburgh. I now introduce to you Professor O'Connor.

PROF. JOHN J. O'CONNOR, JR., Pittsburgh, Pa.: When I was requested to go on the programme again this year I was a little bit reluctant about it, because it is not well to play a return engagement; but the subject was rather a fascinating one, because you can say anything you like on it, and so I accepted it.

Professor O'Connor then delivered his paper as follows:

CIVIC PHASES OF THE SMOKE PROBLEM.

BY JOHN O'CONNOR, JR., UNIVERSITY OF PITTSBURGH.

The problems of modern cities are largely industrial problems. Ancient cities were founded around religious, political or trading centers, modern cities were founded at points where raw materials could be secured or easily assembled for the making of goods. If cities have failed to solve their problems it is not so much the fault of theories of government as it is that industry has failed in service. It has been served. Go through the shame of American cities and you will find at the basis of it a perverted idea of the place of industry in the scheme of things. As some one put it recently:

"Our jerry-built cities, our soot, the cracked paint of our houses, the dusty carelessness of our city life, its flaring second-hand amusements, are the settings in which people lose the vitality to deal with those problems which they dare not fail to solve."

Cities have yet to learn that industry was made for man; not man for industry.

The industrial life and with it, of course, the very existence of a great many of our cities is predicated on coal consumption. It is, therefore, not in the least surprising that cities have found great difficulty in solving a problem which arises out of coal consumption—the smoke problem. To attempt to make a problem out of that which is so close to the very existence of a city seems to some sheer folly. Booth Tarkington in "The Turmoil" has Mr. Sheridan, a manufacturer, express this attitude when he says to a committee of plaintive housewives who called to beg his aid against the smoke nuisance:

"Smoke's what brings your husbands' money home on Saturday night. . . . . You go home and ask your husbands what smoke puts in their pockets out o' the payroll—and you'll come around next time to get me to turn out more smoke instead o' chokin' it off!"

Nevertheless, American cities have long recognized the existence of the smoke problem and have attempted to cope with it. As early as 1804 the burgess of Pittsburgh called the attention of the Borough Council to the smoke evil. It was not until 1881 that cities made the smoke nuisance a subject of legislation. Chicago passed the first general ordinance in April of that year and Cincinnati the following November. It may be interesting to know that almost ten years before this ordinance was passed in Cincinnati, actual cases of nuisances caused by smoke were reported and proceeded against under the general provision with respect to nuisances. Legislative enactments have gone on until now at the Mellon Institute there are on file copies of the ordinances of some seventy-five American cities. The enactment of so many ordinances may indicate a wide spread and live interest in the smoke problem, or it may point to a surpassing faith in the power of legislation.

At all events the concept of the smoke problem has changed; that is the important and hopeful sign. That which was a nuisance and the abatement of which was to be secured by the establishment of facts in each individual case has become the Smoke Nuisance—a community problem. The establishment which now makes objectionable smoke is not looked upon as causing injury or annoyance only to the individual who happens to live next door to it, but to the whole community. Therefore, when the smoke inspector proceeds against the violator of the ordinance he is doing so not on behalf of either a cranky, pesky, irrational or jealous individual, but on behalf of the community.

This has come to pass because cities are having it impressed upon them and are beginning to realize that the smoke nuisance is a serious obstacle to any kind of city planning, that it destroys building materials, retards the growth of vegetation, cuts off sunlight and daylight, prolongs fogs, is injurious to comfort and health, and is costly both to the smoke maker and to the public.

Let me dwell on the last point, for very often persons in favor of smoke abatement are accused, as it were, of placing explosives beneath the foundation of industry. The bituminous coal consumption of this country is something over 400,000,000 tons which is valued at about $460,000,000. It is conservatively estimated that 20 per cent of this coal consumption goes up the chimney as tribute to "King Smoke." This means a loss of about $92,000,000 annually.

That is not all! On the basis of the average cost of the smoke nuisance for cities, in which estimates have been made, the annual cost to the people who live in what the United States census terms "Urban Territory," is about $550,000,000. Cities have every reason to relieve their citizens of the burden of this tax.

Again, city assessors and the courts have taken cognizance of the fact that the smoke nuisance reduces rents, increases the difficulty in letting houses and decreases the selling prices of properties, especially in residential sections.

There is another point on the economic side. It refers to the old cry about driving out business. This cry is often raised when some offenders are hard pressed. It is then asserted that if the smoke ordinance is enforced, manufacturing plants will be compelled to move elsewhere. There is no evidence to support this threat. On the contrary there is abundant proof that the smoky condition of the atmosphere keeps certain very desirable industries from locating in smoky cities and, in the second place, it imposes a heavy tax on industries already located in such cities.

A consideration of these points leads to the conclusion that the abatement of the smoke nuisance, unlike many other social nuisances against which outcry has been made, would result in direct and immediate gain both to the public at large and to those who are chiefly responsible for it.

Cities of this country are doing much to solve the smoke problem, but the citizens have every reason to demand and to bring pressure to bear that the process be accelerated because of health, welfare, comfort and the things which make for civic betterment.

It is to bring about this acceleration that I wish to make three suggestions, not on behalf of cities, but to cities:

The first one is that a city administration should take an active interest in the smoke problem. It is not outside of its duty nor beneath its dignity to do so. The interest should take the form of constructive suggestion and encouragement, not a contemptuous tolerance of the bureau, pernicious interference on behalf of favorite offenders or the sending out of the edict "Go Easy." Any municipal activity breaks down at the point where favoritism enters. I am sometimes inclined to think that the smoke inspector does not secure more co-operation from the city administration because he, himself, does not take the proper attitude on the smoke problem. He often thinks that his is somehow a hopeless and thankless job and the best he can do is to let "bad enough" alone. The smoke problem calls for broad men, men who have a sound fundamental training, men of imagination and men of force.

My second point is that a city should know what its problem is. This may sound foolish, but I doubt if there are more than two cities in this country which have the information on which to base a serious campaign against the smoke nuisance. A city should know what its coal consumption is and its relation to the smoke problem. It should have exact knowledge as to the general source of smoke and a good idea of the amount of smoke made by each source. It should know the location of all stacks and have all significant data on the kinds of installation under them. It should place special emphasis on securing facts as to the ability of the different installations to abate smoke. It should spare no expense to secure evidence with which to convince the most hardened offender of the smoke ordinance that the emission of dense smoke is both wasteful and harmful.

My third point is that with such information a city should diagnose its problem and plan broadly and deeply for its solution. For this purpose the ordinance should be studied to find out whether or not it was simply copied from that of another city or was adapted to the problem at hand. It should decide how much emphasis is to be placed on the abatement of smoke and how much on the prevention of future smoke. The organization of the smoke department should be worked out with reference to the extent and nature of the problem. If it is possible, the smoke bureau should be separated from other activities and set off by itself. This will give to it dignity, obtain for it the proper attention and concentrate responsibility.

Above all, plans should be laid to secure the co-operation of all civic and commercial organizations and institutions of learning that a solid front may be presented in attacking the smoke problem. This is important, whether the plan of procedure is to be one of education or prosecution. No municipal activity in this country is developed sufficiently to reach its goal without the help of organizations which have the welfare of the community at heart. The assistance, the criticism and the approval of civic organizations should be sought after and prized. Institutions of learning in which reside the sciences which have solved so many municipal problems should be recruited for the fight, and the students of engineering schools should be impressed with the necessity of giving attention to problems of combustion. All the forces that are in a community should be called into action to help to solve one of the most difficult problems which confront municipalities.

To summarize:

Most of our civic problems are problems of industry—problems concerned with our very existence. The smoke problem is such a one and for that reason, if for no other, is difficult to solve. Cities are coming to take an increased interest in it. This is due to the fact that points in the indictment of the smoke nuisance have been impressed upon them with new force. Cities have come to know that the smoke nuisance is harmful and wasteful, and that smoke abatement is practicable. Cities with well organized smoke abatement departments which have the support and interest of city administrations, cities which know the problem before them and which have planned broadly and deeply for its solution have every reason to look forward to "noble and joyous cities unbelievably white."

PROF. JOHN J. O'CONNOR, JR., Pittsburgh, Pa.: While I know it is not customary for a man to take up the discussion of his own paper, in order that my paper might not conflict with some papers to be given hereafter, I would prefer that the discussion be confined to two points. The first of them is, the attitude of the city administration in regard to smoke abatement. A number of instances have come to my attention where the Smoke Inspectors have experienced a lack of co-operation on the part of the controlling factors of the city government, whether it was the Mayor, or the Mayor and Council, or whatever the power in control might be. One case came to my attention where a party who was suggested for Smoke Inspector of a certain city in this country, before he would even consider accepting the position, first asked for a conference with the Mayor and Council and with the others in power in the municipality, and wanted to know not only if they would support him in what he was about to do, but whether if a fight was made against him they would stand behind him. It seems to me that that is the only attitude that a Smoke Inspector can take, otherwise he is only holding down a job and forgetting his duty both to the public and the city.

The second is the position the Smoke Department should occupy, whether it should be independent or not. You know that the custom is in most cities of this country to place the Smoke Division under the Bureau of Fires, or sometimes under the Plumbing Inspectors, or in most cases under the Board of Health. It seems to me that it would be well if in some way a discussion could be brought out as to what would be the best method of locating the Smoke Department, as to whether it should be independent, or whether it should co-ordinate with another department. It seems to me the best thing would be to have it an independent department, so that everybody would know who the Inspector was, and so he would know to whom he was responsible. Very often the head of another department under which the Smoke Division is placed is not in sympathy with smoke abatement work, and it is very difficult to get things done on that line. So in the discussion I would like if you would confine yourselves to these two points, the position of the Smoke Inspector in regard to co-operation with the City Departments, and the other, whether the Smoke Department should be independent of other departments, or not.

I thank you.

PRESIDENT TOWNER: Would any one like to enter into any discussion of this at this time? We will have to make the discussion brief and right to the point, because we have quite a number of papers here, and it will be necessary to move right along.

GEORGE WELLINGTON SNOW, Chief of Bureau Mechanical Inspection, Salt Lake City, Utah: I agree with the last speaker on the general proposition that the Smoke Abatement Division of any city government should be entirely independent of any other division. It will perhaps interest you to know how the thing is done in Salt Lake City. The citizens of Salt Lake City have adopted a Commission form of government, and the Commission in carrying out its business has adopted the method, so far as the Health Department is concerned, of creating a Bureau of Health and then letting it have the supervision of everything relating to the public health, such as the inspection of schools and other things that easily come under the direction of the Board of Health.

There are in all cities questions in which the public are interested affecting the mechanical aspects of the city, such as the building department, the sanitary engineering work, plumbing, electrical installation, installation of electrical appliances requiring special knowledge, and finally the question of boiler inspection, which is closely allied to smoke abatement.

So in Salt Lake City they have created the Bureau of Mechanical Inspection, and they have selected what they believe to be the proper man to be Chief of the Bureau, whose duty it is to see that the various things that come under the mechanical lines are properly looked after. That Bureau there is divided into four divisions. The law creates a Chief of the Bureau who is under the direction of the Commission. It also provides that the chief of each division act under the direction of the Commission, which makes for efficiency, and so far has been found to work very well.

We have in Salt Lake City a Chief Electrical Inspector, or City Electrician, who does the work that his title implies. We have a Chief

Plumbing Inspector to look after the installation of the plumbing work. We have a Building Inspector who looks after the fulfillment of the laws in the matter of building; and we have a Boiler and Steam Inspector who looks after the abatement of smoke. Each of these inspectors acts under one chief, the Chief of the Division, who directs his efforts. Finally the four are concentrated under one head, the Bureau of Mechanical Inspection.

I believe that in Salt Lake City this tends to efficiency, to do it that way, for the reason that there are certain seasons of the year when the Building Division is very active, usually in the summer season; also when the Plumbing Division is very active, which is usually in the summer season; and in the winter season when the smoke is the worst, we usually have a fuller opportunity to call in additional help without any special legislation, and we get a great deal of assistance in the Smoke Abatement Division from the other divisions. So that if it is managed right, it will not be necessary to make the Smoke Abatement Division entirely independent of any other. I believe that that carries out the idea that Professor O'Connor suggested, and although the Smoke Abatement in Salt Lake City is one branch of a larger division, we have secured efficiency and have found it to work very well so far.

President Towner: At this particular minute we have John H. Marckworth, President of the Federated Improvement Association of Cincinnati, with us, who would like to say a few words to you at this time.

REMARKS OF JOHN C. MARCKWORTH, PRESIDENT, FEDERATED IMPROVEMENT ASSOCIATION OF CINCINNATI.

I know that your time is very precious, but in the paper by Professor O'Connor dealing with Civic Phases of the Smoke Problem there was mentioned the valuable aid that civic associations can be to municipalities in the solving of this problem. I would like to say that the Federated Improvement Association of Cincinnati is a central organization composed of forty-five civic organizations, and it meets tomorrow afternoon at the Gibson House at 4:00 o'clock, and we will remain in session until 6:00 o'clock. We are very anxious to hear the very latest news and information that you gentlemen bring with you as to how a smoky city can be made less so, and how most efficiently and effectively civic organizations can aid the municipality in this respect. I will be grateful to you gentlemen if you would select one of your number and delegate him to kindly visit us and give us that information at our meeting tomorrow afternoon. I thank you. (Applause.)

W. R. Ranney, Chief Smoke Inspector, Columbus, Ohio: I would like to say in discussing this paper that our ordinance in Columbus coincides with the speaker's views very much, as the Mayor is the only one who is in control of the whole department. I report to him directly and to the City Council. Unfortunately we have a very poor ordinance in Columbus and we want to make it better, and expect to make it better. As suggested by Mr. Monnett in this morning's session, it seems to me that one thing for discussion here and settlement at this time would be the necessity of having a standard smoke ordinance, as well as standardizing installations. It seems to me that if those two problems can be worked out here by this convention, you will have accomplished a great deal.

WILLIAM H. REID, Chief Smoke Inspector, Chicago, Ill.: I want to compliment Professor O'Connor on his very excellent paper. I am somewhat new in this work, but it seems to me that the work of a Smoke Inspector, whether he be for a corporation or for a city, is the same as a sales manager of a large corporation, he must be awake to his duties all the time and full of "pep."

In the City of Chicago we have a mayor who is pledged to do things for the people, and the Smoke Inspector must carry out his pledge. I believe that the Smoke Inspector should work for the interest of the people and let the public know just how much good the Smoke Department is doing for the community. He could show them how to handle their coal in their furnaces; he could show them how much waste there is when coal is improperly handled, and how many tons of coal are carted off to the city dumps in the ash wagons, and how much it costs the city to cart them away.

I know plant owners in Chicago who have never met their firemen, and I have asked them to get acquainted with them and make for a co-operative system between the plant owner and the man who handles the coal.

In Chicago the plant owner is the one we hold liable for violating the Smoke Ordinance. Usually the man who handles the coal is the one responsible, so that a co-operation in this direction will make for less smoke and cleaner and purer air. Co-operation between plant owners and the firemen; co-operation between plant owners and the Smoke Department; and co-operation between the Smoke Department and the City Government, seems to be the theme upon which a successful Smoke Department can be conducted and the desired results obtained.

The results obtained from this method in the City of Chicago have been marvelous and there is a better feeling toward the Smoke Department. They know the Smoke Inspectors are human and they know the Smoke Inspectors are working for their good.

The Smoke Inspector or engineer of the Smoke Department acts as a consulting engineer to the plant owner, without pay. He makes for him, economy; he makes for him, efficiency.

I will say, gentlemen, that if we want our various Smoke Departments to amount to anything in our various localities, we must work co-operatively, energetically, and diligently, so that we can benefit the coal consumer on the one hand, and the people at large on the other, by creating a condition of pure, fresh air, and less dirt, which is one of the greatest works that can be done.

Gentlemen, I thank you. (Applause.)

President Towner: Has any one else anything to offer in discussion of this paper? If not, we will pass to the next number, which is a discussion of "Value of Organization in Smoke Abatement Work." I understand that Mr. Edward S. Jerome, Superintendent of the Smoke Abatement League of Cincinnati, has offered to open the discussion on this topic. Gentlemen, Mr. Jerome.

VALUE OF ORGANIZATION IN SMOKE ABATEMENT WORK.

BY EDWARD S. JEROME.

Mr. President and Gentlemen:

It would hardly seem necessary in this Twentieth Century, in this period in our American life, to discuss the value of organization. It is but uttering truisms or accepted axioms, because it is a self-evident proposition. There is not a church in the world, or political party, or Masonic or any other lodge, or any body of men that have gotten together for a good time, or to advance certain objects, who do not fully understand the advantages of organization.

Webster defines the word as simply a means of organizing or getting together in what we know as team work, or concentration, or combination, which latter expresses the whole thing in a nutshell.

It is quite remarkable that a man who was supposed to have been a dreamer asked the question one hundred years ago, "What is organization?" and replied that it was the connection of parts to form a whole so that all in general might work toward a predestined end.

Now one of the best illustrations that may be cited of organization in the United States was the movement against American slavery. One hundred years ago about this time there was a man who had a concept on that point. I do not speak of this to discuss party problems, but I want to use this to illustrate my point. Among those who were opposed to American slavery there was a simple New Jersey Quaker by the name of Benjamin Lundy. He came West and lived here in Ohio and also in

West Virginia. He was the first man that we have record of, barring Washington and other men who did not believe in it, but took no active steps against it, who formed an organization against that great evil. This man had the conception and proceeded to organize himself into a Committee of One. Every great movement begins with one man, and if it is the real thing it is a call to that man, and it soon spreads and the cause is taken up by millions. The next man whom he enlisted in this cause was William Lloyd Garrison. Lundy soon passed away, and Garrison carried on the work for thirty years, and you know what the final result was. That to my mind is the most striking example of organization. In spite of the passion, hatred and bitterness generated by their work, and in spite of the fact that for the time being the American people did not agree with their methods, the final result was that slavery was abolished.

We have today to deal with the great question of smoke abatement, and if we were to say that this could only be done by organization, it would sound like a truism. Yet we have to discuss the matter.

Pardon me for personal allusions to our own city; but this League that I have the honor to represent was originated by a handful of good people, who got together and organized the Smoke Abatement League some ten years ago. Twenty years before some good women had organized, and they were the ones that secured the ordinance of 1881. The leading spirit in that initial movement in Cincinnati for smoke abatement passed away this year. For twenty-five years that ordinance was not enforced. Why? Because there was no organization. There was a certain amount of public work done, and the ordinance was passed, but it was allowed to lie on the books as a dead letter. One of our Mayors said that our city was so situated within the rim or basin of the hills that the wind would not blow the smoke away, and hence the ordinance was practically null and void. Today that gentleman is converted to the opposite view. That is only one illustration of the effect of organization. You have organization at every turn, in your church, in your business, but you cannot have it without combination and without method.

If there were no organization in this Association we would not be meeting here today. Why? Because there would be no coherence, no rallying point, no head, no central body by which all this energy could be directed.

To discuss this is almost child's play, because it is so overwhelmingly apparent in our American life. Take every Chamber of Commerce in the various cities of our country, they, as well as our Chamber of Commerce in Cincinnati, have various centers of organization within themselves that specialize on grain, wheat, hay, oats and a hundred other things. They work for play-grounds, for better tenements, for better water, for better schools, for an enlarged public school curriculum, in a thousand ways; every central body which is strong and powerful, is so in exact proportion to its perfection of organization. You will all agree to that proposition, I am sure; so that I do not feel that any long discussion of this topic is called for. Certainly it is one that has not been thoroughly prepared by me so far as writing a paper is concerned.

I am sure that we will all agree that organization is necessary. Let each one of you get busy in your own towns if you have no organizations to carry out the purpose of this Association.

Sometimes those who busy themselves in public matters are termed busy-bodies; but this term should not be applied to them or to any man who is working to abate a nuisance. He is no butter-in, he is a friend to the community. We are not any of us perfect or angelic necessarily, but any good man or woman throughout the city, town or country, who is working to abate the smoke nuisance should be considered as a friend of that community.

Our little suburb of Norwood organized the other day a Chautauqua, and for seven days those good people had some of the finest speakers we have in the country. A few people of the town raised a large amount of money to be spent for civic improvement. This creates civic pride, and it is due to the organization of good men and women banded together, through which they can accomplish work which none could do alone. Have a method of working, and success is bound to come—failure is impossible. (Applause.)

PRESIDENT TOWNER: Has any one any questions to ask, or any discussion to offer on this topic?

WM. A. HOFFMAN: I have a few remarks to make on organization. I represent the Smoke Department of St. Louis. These are my own impressions, but there are many other valuable facts connected with organization that I shall not mention.

Organizers in smoke abatement have been pioneers in the work of creating public opinion in favor of smoke abatement and usually they have been the organizers of city departments for smoke abatement, and as such they should be given full value and credit for their work.

Organizations for this work consist of the Smoke Abatement Commissions, of Civic Leagues, City Clubs, Business Men's Leagues, and in not a few cases, organizations formed solely for smoke abatement; and in special, though unusual cases, individuals have given their time and support for the smoke abatement cause.

In the various civic organizations there should be a Smoke Abatement Committee. Union meetings of all committees should be held to take up and discuss plans for the year, review the work of the city department, and uphold its work if well done, criticizing where necessary.

The problems of the smoke inspector should be studied and discussed, and in all matters as much as possible organizations should co-operate with him. These features are being better understood and the general survey of smoke abatement problems and the smoke abatement work in all its phases, even to details, is now better known and appreciated than formerly.

I believe that the organizations should create and maintain a strong public opinion for smoke abatement. Without this the work of the Smoke Abatement Department is handicapped. While the smoke inspector may by force and persuasion accomplish good, it will be only known to those with whom he has come in contact. True, his work should be to create a public sentiment in favor of smoke abatement; but his means for so doing are limited. If he had the proper means, his intentions might be questioned, if he gave them full rein.

Some organizations do effective work by issuing pamphlets, but these have only a limited circulation. Publicity reaches the masses through the medium of the newspapers. It has been said that one reason why news of an engineering nature does not get into the daily papers is because the ordinary reporter has not the technical knowledge to handle it. News, it must be remembered, is nothing more than ideas and facts put into interesting and readable form so as to be intelligible and easily understood by the community at large. Everybody reads. If they read nothing else, they read the newspapers, so it is the most direct way to reach the greatest number through the daily press. An important point in favor of the newspaper is that it is local and offers an opportunity for organizations to place in its columns engineering news that has an especial appeal to the community.

Most people have a friendly attitude toward one of their local papers, and are ready to accept as authentic what they read in its columns. So the community will learn about its citizens and what they are doing to promote the city's welfare. For these and other reasons, such as frequency of appeal, we are inclined to give newspapers the place of first importance in publicity work.

As a result of publicity numerous complaints as to smoke will be received, and investigations made in consequence thereof will show that many of these are not well founded. One is amused at reading some complaints as to what is expected of the Smoke Abatement Department.

If organizations will inform complainants of the scope of the city's smoke abatement laws, much time and expense will be saved in making investigations as to complaints of a questionable character or which have no legal foundation.

The value of organizations in smoke abatement work is best judged by their activities, being as follows:

1. Initial movement in smoke abatement work, the creating of public opinion for smoke abatement, framing ordinances, and having same enacted into laws in which dense smoke is declared a nuisance. I doubt very much if a smoke abatement law would be in our municipal codes were it not for the work of organizations.

2. The appointment of active smoke abatement committees with union meetings of these committees. At such meetings there should be discussed past year's work, the progress determined, if any, and a study of future work and various special features requiring study and thought undertaken; also a review of the past year's work of the city department, and in addition publicity of matters relative to smoke abatement should be considered, and ways and means provided for promoting the same.

J. H. Lewis, Chief Smoke Inspector, C., B. & Q., Chicago, Ill.: Talking about organization, I think that Chicago, if I do say it myself, has the best organization for the prevention of smoke in the United States of America, and that is putting it pretty strong.

In the first place, the railroad smoke inspectors have an association of their own there, representing thirty-three different railroads. These railroad smoke inspectors meet twice a month and confer with each other in regard to how they can assist each other. For instance, if a Northwestern smoke inspector happens to be passing along over the Burlington railroad track and sees an engine smoking, he does not keep that to himself, but he reports it to me, and I take it up with the engineer. If I see a Northwestern, a Rock Island, or any other railroad engine smoking, I report it to the Smoke Inspector of that railroad.

A couple of years ago in Chicago we had some bad stacks where dense smoke was being emitted and the City Smoke Inspector requested the Railroad Smoke Inspectors to take the matter up with the railroads and try and bring them to time. They did so. That was the effect of the organization between the railroad men and the city smoke inspector.

Now I want you to understand that I am not afraid of the City Smoke Inspector of Chicago and never was, because when we have gone down there with anything we thought was something we were mistreated on, we always got satisfaction. On the other hand we have always been ready to co-operate with the city department and to help them out in any way that we could. That is the way we are working it in Chicago at the present time.

Every report that is turned in against a railroad in the city of Chicago goes to what is called the General Managers' Association. If I report the Northwestern tomorrow to the Chief Smoke Inspector, I also report it to the General Managers' Association, and the Chairman of the General Managers' Association of all the railroads in Chicago reports that to the General Manager of the road that is at fault. So you can readily see that we are up against a proposition there that I do not believe is paralleled in any other city in the United States.

I want to say that when you get your organizations so that your men will work with each other, so that you can feel at home and when you get down to the City Hall you can feel at home there, men will come to your meetings, then you are going to get conditions that will eliminate smoke; and as far as I know in the city of Chicago we are doing good work and have done good work—not that I am saying that we have done that because I am from Chicago, but let us tell the truth once in a while.

PROF. JOHN J. O'CONNOR, JR., University of Pittsburgh: I would like to have somebody explain the organization of the various civic clubs of Chicago and how they do it. For my part I think that Cincinnati has the ideal situation in the method of organization with one exception. I do not understand why it is that the Cincinnati Smoke Abatement League is not a member of the United Smoke Committees of Cincinnati.

EDWARD S. JEROME, Supt., Smoke Abatement League, Cincinnati: You are mistaken in that, or at least we co-operate with them.

PROF. JOHN J. O'CONNOR, JR., University of Pittsburgh: You can have too much organization of course, you can have organization that suppresses facts. I think co-operation among organizations without their losing their identity is about the best thing. The situation in Cincinnati is ideal, in that they come together for this one purpose, and then they can do their own work in whatever way they please.

PRESIDENT TOWNER: Has any one else anything to say on this subject?

EDWARD S. JEROME, Supt., Smoke Abatement League, Cincinnati: Let me explain the reason why the Smoke Abatement League of Cincinnati has not been a member of this United Smoke Committee, because heretofore we understood that no one but regular city officials were eligible to become members. That is what I wrote Mr. Harris, the predecessor of Mr. Viall, in Toronto, some years ago, when I asked him if we might not join? He said, no, because we were not regular city officials; but I understand that your scope has been enlarged, and hence we are glad to be included.

Prof. John J. O'Connor, Jr., University of Pittsburgh: You misunderstood me. I asked why the Smoke Abatement League was not a member of the United Smoke Committees of Cincinnati.

Edward S. Jerome, Supt. of Smoke Abatement League, Cincinnati: We attend their meetings and are heartily in favor of this movement.

E. F. DeBrul, Cincinnati, Ohio: I am reminded of a remark that was attributed to John Burns, the member of Parliament and representative of the laboring element in England. He said that any social movement has three distinct and well-defined stages; first, the agitation stage; second, the organization stage, and third, the education stage. I take it that in a city where there is a smoke department of any sort for which taxes are paid by the city government that the agitation stage has, at least, gone far enough to develop the organization stage. In this city the smoke inspector has been working with the commercial organizations, agitating among the commercial organizations and carrying the agitation stage still further so as to develop a wide organization and thus we are coming to the third step or stage of education.

I can speak as a manufacturer whose own plant has made a great deal of smoke, although it is not our fault. We did all that was possible as long as it was not a matter of persecution. We did all that we knew how to eliminate smoke, and we could not get any further, and we did not make much progress then until the smoke inspector came to our plant and talked with our foreman and showed him how an improvement could be made by abandoning the old system of throwing all the coal in front where it was supposed to be coking, then pushing it all back, and sending out clouds of smoke at very frequent intervals. Our men have been shown how to fire properly according to the methods that are recommended by the government in their bulletins, and a geological survey, and now we have begun to get results that have reduced our smoke; and the same results can be obtained in any hand-fired plant. I say, bear in mind that there are three steps, then it will be easy to follow them out.

President Towner: Has any one else anything to say on this question? If not, the next in order is paper on "Starting the Work of a Smoke Department," by Mr. Martin A. Rooney, Chief Smoke Inspector, Nashville, Tenn. (Applause.)

Martin A. Rooney, Chief Smoke Inspector, Nashville, Tenn.: It has sometimes been said that you can judge the size of a man by his ability to start something. We do not claim in Nashville that we have done very much, or that we are very big. We are not able to brag very much about the work that we have done in our Smoke Department, but we do claim that we have started something.

STARTING THE WORK OF A SMOKE DEPARTMENT.

MARTIN A. ROONEY, M. E., CHIEF SMOKE INSPECTOR, NASHVILLE, TENN.

The work of beginning the enforcement of a smoke law starts long before the smoke ordinance itself comes into existence. It begins when some few citizens of a community, more keenly conscious of their civic duties than the great mass, begin to call the attention of the public to the fact that pure air is just as valuable and just as necessary to public health and comfort as pure water, sanitation and other community conveniences.

The fact that any community enacts a smoke ordinance augurs well for the success of their smoke department for its very passage indicates the existence of an educated and enlightened public sentiment and this sentiment is the most necessary factor in a successful campaign against the smoke nuisance.

Of course, the smoke ordinance adopted should be practicable, legal and in general should follow the pattern of the best ordinances that are in force today. In fact the best advice that can be given to any set of citizens enacting a smoke ordinance is that they follow the lead of other successful cities in this regard and avoid some of the actually ludicrous mistakes that have been made by uninformed and antagonistic city fathers in creating anti-smoke laws.

The personnel of the officers appointed to enforce the smoke laws is of the utmost importance. The smoke inspector should be a practical engineer trained in the construction and operation of boilers and furnaces. He should, if possible, be appointed by civil service methods and should, of course, possess a pleasing manner, tact, honesty, etc., in fact, he should possess a little of all the virtues, he will need them on his job.

Of course it is always well worth while to know what the other fellow is doing and before any smoke inspector starts his work it would be well for him to visit other departments and study their working methods. Before we started our smoke work in Nashville, the city sent the smoke inspector on a six weeks' trip to other cities, and I believe I can safely say were it not for the assistance and hearty co-operation of the older departments, our efforts would have certainly resulted in failure.

The plan of campaign or what is the same thing, the system used in carrying on the smoke work, is of course, of vital consequence. The system used in Pittsburgh or Chicago would, of course, be entirely too complicated for a small city and the system used in a smaller town would be inadequate for a large city. The smoke inspector in determining on his methods and policies must, of course, act with good judgment, taking into account the peculiarities of his local problem and it is hardly likely that he can get any assistance in this regard from any outside source. He will have to use his own good judgment based on his knowledge of local conditions.

A smoke department starts on its work under peculiar and difficult conditions. You will usually find that a large percentage of the citizens don't know what the whole thing means. Some of them will think that an impossibility is being attempted while others will scent political trickery and suspect the creation of a good fat job for somebody. Of course, the smoke inspector will have to overcome these opinions or in time they will overcome him, and if I could say anything that would enable one inspector in any one city to gain part of the public good will, I would feel that I had accomplished a great deal.

In our work in Nashville we have tried to gain and hold the good will of the public by being always honest, straightforward and courteous in our dealings with the public and with the plant owners. We have avoided all unnecessary antagonism and have always borne in mind that we were the servants of the public. The attitude of the plant owner has always been friendly toward our work for we have endeavored and succeeded in showing most of them that to adopt modern methods of furnace operation and construction would not only result in minimizing their smoke but would result in large savings to themselves and it is now a fact that some of the strongest opponents to the passage of the smoke ordinance have become the warmest friends of the smoke department.

Another important advice I would give to anyone starting on this work is to take the public into your confidence and endeavor to get into theirs. Keep them informed of everything you are doing or intend to do. You will find that the newspapers are only too glad to print news concerning the work, for it is a fact that every citizen is interested in all of the functions of the municipal government and any information concerning any department is of such news value that the papers are usually glad to print it and it might be stated that unless you have the sympathy and co-operation of the local papers, the chances are that your work will not succeed.

And finally if I should adopt a motto for the smoke inspector it would be "go easy." The conditions which you are attempting to change have grown up for hundreds of years and it is not to be expected that you can completely change them in a day or a year. You are attempting to change the habits of thousands of men and if you would understand how difficult this task is going to be, try breaking one habit of your own.

Of course a smoke inspector will have his difficulties. You will encounter the man who will charge you with all the sins on the calendar. You will encounter the man who says that soft coal cannot be burned without smoke. You will even occasionally run into that old story that smoke is a sure sign of prosperity, that it is the deterrent of disease and that it is altogether desirable.

Of course it is our duty to overcome these difficulties and I believe I can say without any degree of boasting that we who are gathered here in this convention are overcoming them and that this *art of smoke prevention is advancing with more rapid strides than any of the other of the public arts.*

DISCUSSION.

President Towner: Has any one any question that he would like to ask Mr. Rooney, of Nashville, or any point that he would like to add to the paper?

E. J. Summers, Chief Smoke Inspector, C., M. & St. P., Chicago, Ill.: I would like to ask Mr. Rooney why he considers a Mechanical Engineer a more beneficial man as a Chief State Inspector than a practical engineer.

Martin A. Rooney, Chief Smoke Inspector, Nashville, Tenn.: I do not think that a Mechanical Engineer is a mechanical engineer until he is a practical engineer. What I mean by a Mechanical Engineer is a man who has knowledge of mechanics and mechanical apparatus. In this particular instance what I mean by Mechanical Engineer is a man who has had actual experience in running and operating power plants, or in burning coal in some way. I do not think that an engineer is necessarily a man who has been through a certain number of books, or who has listened to professors orate for a certain number of hours, that is not an engineer. What I mean by a Mechanical Engineer is a practical Mechanical Engineer.

W. E. Porter, Assistant Chief, Bureau of Smoke Regulation, Pittsburgh, Pa.: There is one point that concerns us all that Mr. Rooney spoke of there, and that is this, that we have had it very forcibly brought to our attention on several occasions that we were "public servants," and that the corporations were the people that were paying the taxes and were the ones that were bearing the burden of our support. I want to say right here that Mr. Henderson very frankly said in such a case as that, "Yes, we are public servants of the men who obey the laws, but we are not public servants of the men who break the law." I think that that is good attitude for smoke inspectors to take. (Applause.)

Roy L. Peck, Chief Engineer, The Great Lakes Dredge & Dock Co., Chicago, Ill.: I would like to ask Mr. Rooney if the ordinance in force in Nashville makes the penalty to apply to the man who makes the smoke, the fireman say, or whether it simply assesses a fine on the corporation, or the man who owns the boiler?

MARTIN A. ROONEY, Chief Smoke Inspector, Nashville, Tenn.: The ordinance states that owners, managers, firemen, engineers, or anybody who is responsible in any way is liable to the penalty. I have never, except in one case, had a fireman arrested, and when I had him arrested I also had the president of the company he worked for.

PRESIDENT TOWNER: Has any one else anything to say on this question?

W. H. MOORE, City Smoke Inspector, Memphis, Tenn.: On the question of limitation as applied to locomotives or yard engines, I would like Mr. Rooney to explain a little further in regard to that.

PRESIDENT TOWNER: The railroad men will all be here tomorrow and that will probably come up then.

MARTIN A. ROONEY, Chief Smoke Inspector, Nashville, Tenn.: What Mr. Moore refers to is this: Most of these smoke ordinances provide that dense smoke is a nuisance and that the emission of dense smoke subjects a man to a fine, except for six minutes in one hour, during which time the firebox is being cleaned and a new fire being built. Now that means strictly interpreted that no smoke at all can be emitted from a stack at all except when a fire is being cleaned. Now on a locomotive they never clean a fire at all while a locomotive is running, and the fire is not being built or cleaned because the very fact that the locomotive is running is evidence that such is not the case. In most places they provide that one minute of dense smoke emitted by a locomotive is a bad performance.

In our practice in Nashville we report to the City Smoke Department and they to the railroad. We report as a violation every observation that we make where there is an emission of over one minute of dense smoke, and the railroads consider that a violation. I believe I am right on that. That is what you were trying to get at, is it not, Mr. Moore? We have never had that in court, but as a matter of fact in our dealings with the railroads we have never quibbled over any technicality. Railroads there accept the decision of the City Smoke Department as to what is bad practice. I think the railroads are strict with the men among themselves, and they co-operate with the City Smoke Department.

PRESIDENT TOWNER: The next paper on the program is on the "Value of Publicity in Smoke Abatement Work, and Methods of Obtaining It," by J. W. Henderson, Chief Smoke Inspector of the Bureau of Smoke Regulation, Pittsburgh, Pa. (Applause.)

THE VALUE OF PUBLICITY IN SMOKE ABATEMENT WORK, AND HOW TO OBTAIN IT.

BY J. W. HENDERSON, CHIEF, BUREAU OF SMOKE REGULATION,
PITTSBURGH, PA.

One might go out on the street corner and swing his arms and yell at the top of his voice, and keep this up until he lands in the police station; or commit any kind of foolhardy feat; or exceed his fellows in any destructive act; and he will receive publicity of more or less extent. It is the kind that is called notoriety.

There is all the difference imaginable between becoming notorious and being famous. The former is the occasion for public criticism and public condemnation, while the latter is the attainment of public respect and public applause. The one is founded upon weakness or vanity, or both, and the other upon personal effort in a good work of benefit to the community and the country.

It is along the line of this latter aspect of publicity to which the title of this paper has reference. If this effort results in further publicity for our commendable work of smoke abatement, it shall be worth while.

Publicity is the product of, and results from, effects upon human intelligence. As we have no exact standard of measure for effects made on intelligence, so there is no possibility of tabulating publicity values. Confining ourselves to the subject of smoke abatement work, we shall mention some values from the publicity we have been instrumental in obtaining and which has been given our work in Pittsburgh by the newspapers, associations, organizations and individuals.

The value of publicity in our smoke abatement work lies, broadly speaking, in the public sentiment which it has awakened and maintained. This it does by attracting attention generally to the work itself, by the enlightenment of those directly and indirectly affected, and which is by no means of least importance by arousing to activity all those persons who are ever ready and willing to "line up" with a going proposition that in itself is commendable.

This covers a great deal in little space and perhaps you will say that you knew it beforehand. Buried in the statement, though, is the fact that the smoke offenders themselves are stirred to action towards compliance with the law, without even a trace of hard feelings toward any one. Many of them merely obey an impulse to "join the procession" of those interested in a good work. The results are progressive and tend to permanent abatement. Such compliance with the law is more constructive than securing the same immediate tangible results by force. What human beings do by being *impelled* to act through awakened innate desire is far better and more lasting than when *compelled* to do the same things by an outside force.

This is the key to the whole situation as well as the guide to the object to be gained by publicity. It necessitates acceptance of the statement that there is in every person the desire to do what is right. Awaken that desire on your side and the end sought is in sight. One must first be right himself though.

We now come to a phase of our subject that is not so easy to explain or elucidate. "How to Obtain Publicity in Smoke Abatement Work." You might almost as well ask a person who is naturally "a good fellow," how he, or she, makes friends so easily.

About the best that can be done is to mention certain methods employed by us and show you some examples of the publicity which smoke and smoke abatement have received, since March 6th and April 1st, 1914, the dates of appointments of those at present in charge of smoke abatement in Pittsburgh. The examples to be referred to will be shown in pictures thrown on the screen.

We started right in making our appeals for action to the highest officials, especially in the large corporations, responsible for the conditions we were compelled to take note of. Generally we addressed ourselves to presidents. If they turned us over to minor officials, we continued to send copies of all reports and correspondence to them.

Photographs of offending stacks were sent to the presidents. Accompanying these photographs were letters which stated the photographs were sent to attract attention and awaken interest in smoke abatement, and requesting a reply advising when abatement might be expected.

Almost simultaneously an ordinance came up in our business men's council proposing to prohibit the use of bituminous coal on locomotives in switching service within the city limits. An open meeting with a committee of council was held and it was attended by high officials of the railroads and their attorneys. We had photographs taken in all the different railroad yards and these, together with a personal investigation, enabled the Bureau Chief to state at this meeting that the locomotives were not then complying with the law. Action by council was deferred pending a report of findings by the Chief of the Bureau of Smoke Regulation after he should meet with the railroad officials and discuss the situation and the probabilities of securing compliance with the smoke ordinance. This was the beginning of our meetings, first with officials and operating men of the railroads and later with the other interests responsible for the production and emission of smoke.

Up to the present time we have had meetings as follows:

April 9, 1914—R. R. men. 20 present.
May 26, 1914—R. R. men. 46 present.
August 4, 1914—R. R. men. 60 present.
September 2, 1914—Mfg. 48 present.
December 2, 1914—R. R. men. 80 present.
March 19, 1915.—R. R. men. 60 present.
March 24, 1915—Mfg. 61 present.
July 1, 1915—Mfg. 76 present.

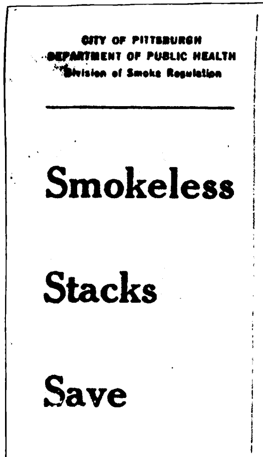
In the notice calling these meetings, the parties were asked to present reports, preferably written, showing what had been done towards smoke abatement and what could be promised in the immediate future. With few exceptions which now do not exist to the same degree, the responses were indicative of willing co-operation with the city in its efforts to bring about smoke abatement.

This was the foundation of our publicity because the subject was put up to the representative men of the community in this public manner. Generally, where such men stand, on any question, you will find their families, the average citizen, the different associations and organizations, and the newspapers.

The information presented at these meetings was of mutual benefit and general interest. This was brought out by calling upon the different representatives in alphabetical order of the firm names, for reports covering their efforts to meet the requirements of the ordinance.

As a result of these meetings and in connection with them and from other general and special activities of our own, we made possible the publicity which will be demonstrated in a very *condensed* manner by the pictures which will now be thrown on the screen.

Plate No. 1 shows the front and reverse sides of three different postal cards. The upper left hand is the front lettering on all three cards. The lower left is of a yellow card mailed to engineers, architects and contractors calling attention to the provision in the ordinance covering the matter of making application for permit for the construction, reconstruction, alteration or repair of any boiler, furnace or stack or apparatus connected with a stack.

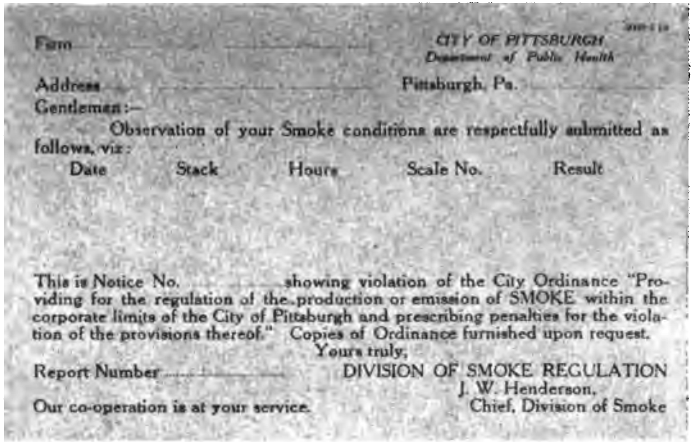


CITY OF PITTSBURGH
DEPARTMENT OF PUBLIC HEALTH
Division of Smoke Regulation

Smokeless

Stacks

Save



Firm .... CITY OF PITTSBURGH
Department of Public Health
3000-3 14

Address .... Pittsburgh, Pa. ....

Gentlemen:—

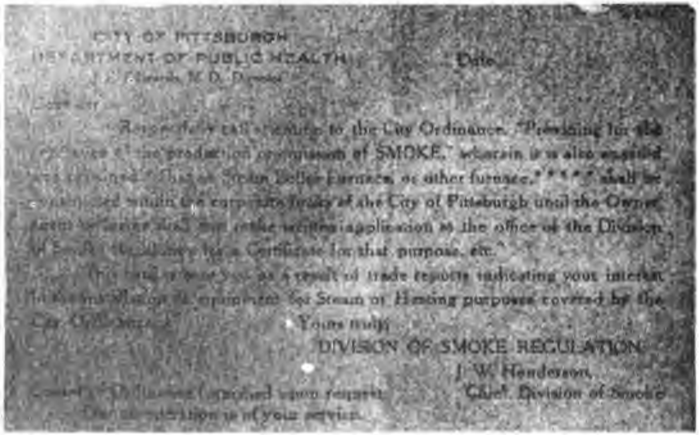
Observation of your Smoke conditions are respectfully submitted as follows, viz:

Date	Stack	Hours	Scale No.	Result

This is Notice No. .... showing violation of the City Ordinance "Providing for the regulation of the production or emission of SMOKE within the corporate limits of the City of Pittsburgh and prescribing penalties for the violation of the provisions thereof." Copies of Ordinance furnished upon request.

Yours truly,

Report Number .... DIVISION OF SMOKE REGULATION
J. W. Henderson,
Our co-operation is at your service. Chief, Division of Smoke



CITY OF PITTSBURGH
DEPARTMENT OF PUBLIC HEALTH Date
J. F. Edwards, M. D., Director

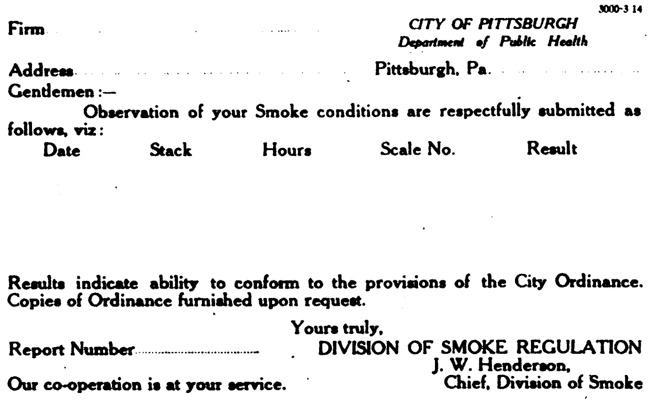
[illegible]

Respectfully call attention to the City Ordinance "Providing for the [illegible] of the production or emission of SMOKE," wherein it is also enacted [illegible] "That no Steam Boiler furnace, or other furnace,* * * * shall be [illegible] within the corporate limits of the City of Pittsburgh until the Owner [illegible] shall [illegible] application at the office of the Division of Smoke [illegible] for a Certificate for that purpose, etc."

This card is sent you as a result of trade reports indicating your interest in the installation of equipment for Steam or Heating purposes covered by the City Ordinance.

Yours truly,

DIVISION OF SMOKE REGULATION
J. W. Henderson,
Copies of Ordinance furnished upon request. Chief, Division of Smoke
Our co-operation is at your service.



3000-3 14

Firm .... CITY OF PITTSBURGH
Department of Public Health

Address .... Pittsburgh, Pa. ....

Gentlemen:—

Observation of your Smoke conditions are respectfully submitted as follows, viz:

Date	Stack	Hours	Scale No.	Result

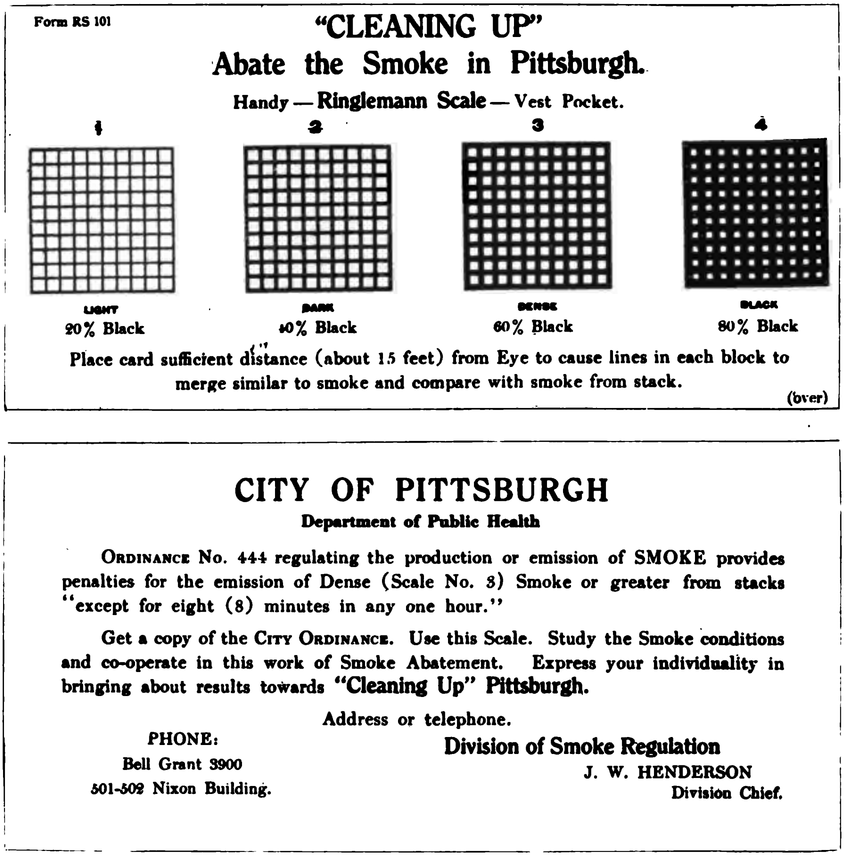
Results indicate ability to conform to the provisions of the City Ordinance. Copies of Ordinance furnished upon request.

Yours truly,

Report Number .... DIVISION OF SMOKE REGULATION
J. W. Henderson,
Our co-operation is at your service. Chief, Division of Smoke

Plate 1

The upper right view is that of a gray card for the purpose of not only reporting violations at little expense but also to give prominence to the fact of the violation by the mere color of the card. The lower right-hand view is of a white card for reporting results of investigations and observations indicating the ability to operate with the stack within the law.


Form RS 101

"CLEANING UP"

Abate the Smoke in Pittsburgh.

Handy — **Ringlemann Scale** — Vest Pocket.

1	2	3	4
LIGHT	DARK	DENSE	BLACK
20% Black	40% Black	60% Black	80% Black

Place card sufficient distance (about 15 feet) from Eye to cause lines in each block to merge similar to smoke and compare with smoke from stack.

(over)

CITY OF PITTSBURGH

Department of Public Health

Ordinance No. 444 regulating the production or emission of SMOKE provides penalties for the emission of Dense (Scale No. 3) Smoke or greater from stacks "except for eight (8) minutes in any one hour."

Get a copy of the City Ordinance. Use this Scale. Study the Smoke conditions and co-operate in this work of Smoke Abatement. Express your individuality in bringing about results towards **"Cleaning Up" Pittsburgh.**

Address or telephone.

PHONE:
Bell Grant 3900
501-502 Nixon Building.

Division of Smoke Regulation
J. W. HENDERSON
Division Chief.

Plate 2

Plate No. 2 shows the face and reverse side of a 2¾x6 in. card under the caption "CLEANING UP."

Cleaning up was occupying public attention early in 1914, when these cards were made up. Some of the department stores enclosed them with their bills at the end of the month. The balance of the 20,000 distributed were given out at the noon luncheons of the various clubs and a noon luncheon of the Chamber of Commerce of Pittsburgh, and also at meetings of the Engineers' Society of Western Pennsylvania and the National Association of Stationary Engineers. They served to educate people in the use of the Ringlemann Scale and the provisions of the city ordinance in force at that time.

Plate No. 3 presents clippings from various newspapers referring particularly to our meetings with the railroad representatives. The prominence of the space and the headings indicate the importance attached to these meetings thus reported. You will note the headings are "Roads in City Abate Smoke," "Railroads Aid in Smoke War," "Smoke Nuisance Will Be Subject of Conference," "Smoke Going, Conferees Say," "Railroads Must Abate Smoke," "Railroads Report on Smoke Abatement" and "Regulating Smoke."

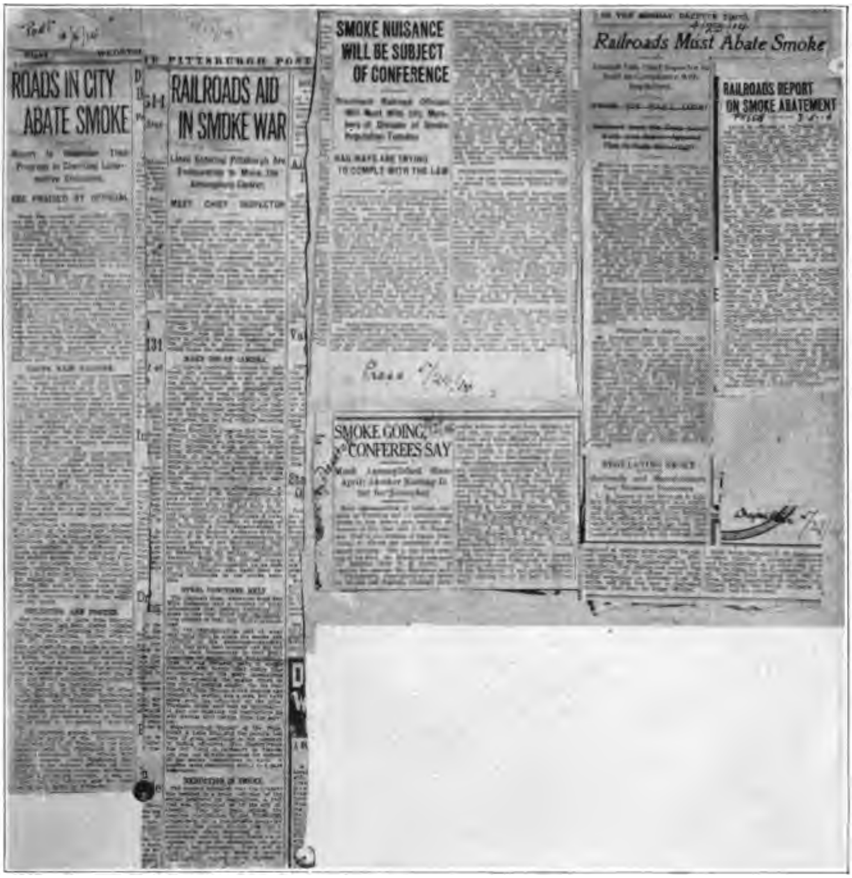


Plate 3

ROADS IN CITY ABATE SMOKE

PITTSBURGH POST

RAILROADS AID IN SMOKE WAR

SMOKE NUISANCE WILL BE SUBJECT OF CONFERENCE

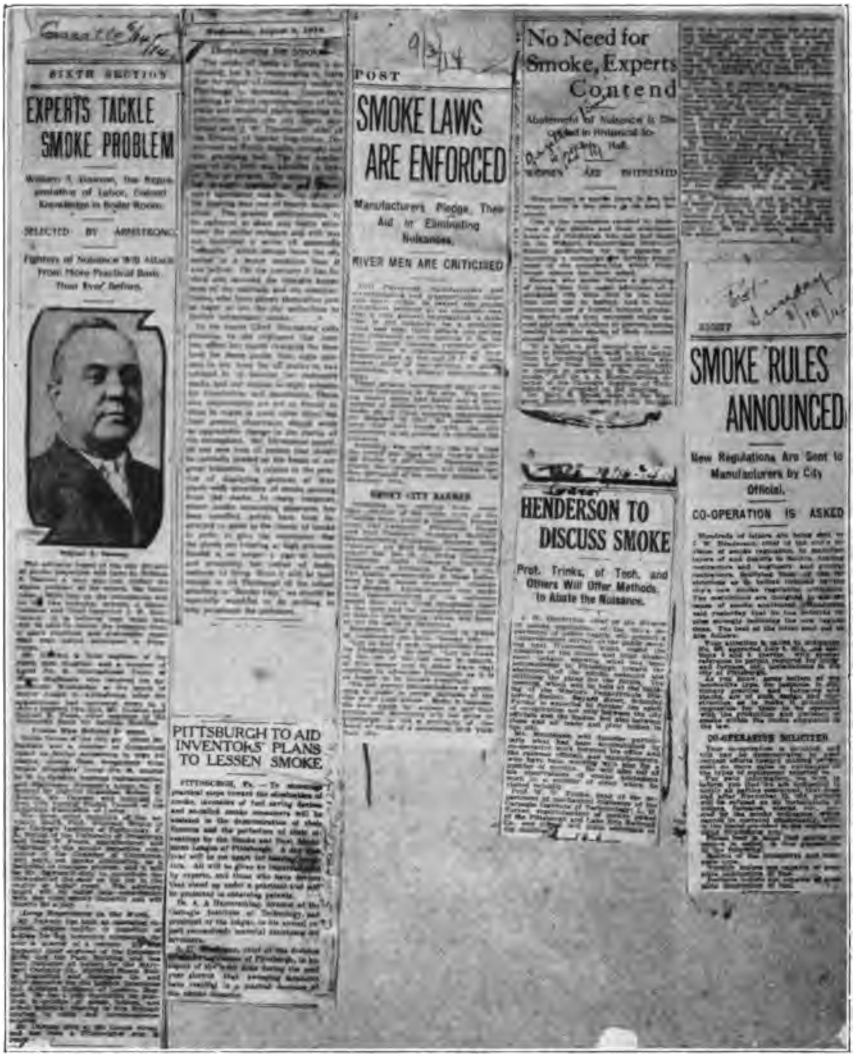
RAILWAYS ARE TRYING TO COMPLY WITH THE LAW

SMOKE GOING, CONFEREES SAY

Railroads Must Abate Smoke

RAILROADS REPORT ON SMOKE ABATEMENT

Plate No. 4 has copies of clippings from our local papers in regard to the appointment of the Advisory Board to work with us on engineering phases of smoke abatement, and covering more insistent demands for action leading to obtaining compliance with the city ordinance. There is also a clipping taken from the Christian Science Monitor of Boston referring to the annual meeting of the Smoke and Dust Abatement League



SIXTH SECTION

EXPERTS TACKLE SMOKE PROBLEM

9/3/14

POST

SMOKE LAWS ARE ENFORCED

Manufacturers Pledge Their Aid in Eliminating Nuisances.

RIVER MEN ARE CRITICISED

No Need for Smoke, Experts Contend

HENDERSON TO DISCUSS SMOKE

Prof. Trinks, of Tech. and Others Will Offer Methods to Abate the Nuisance.

SMOKE RULES ANNOUNCED

New Regulations Are Sent to Manufacturers by City Official.

CO-OPERATION IS ASKED

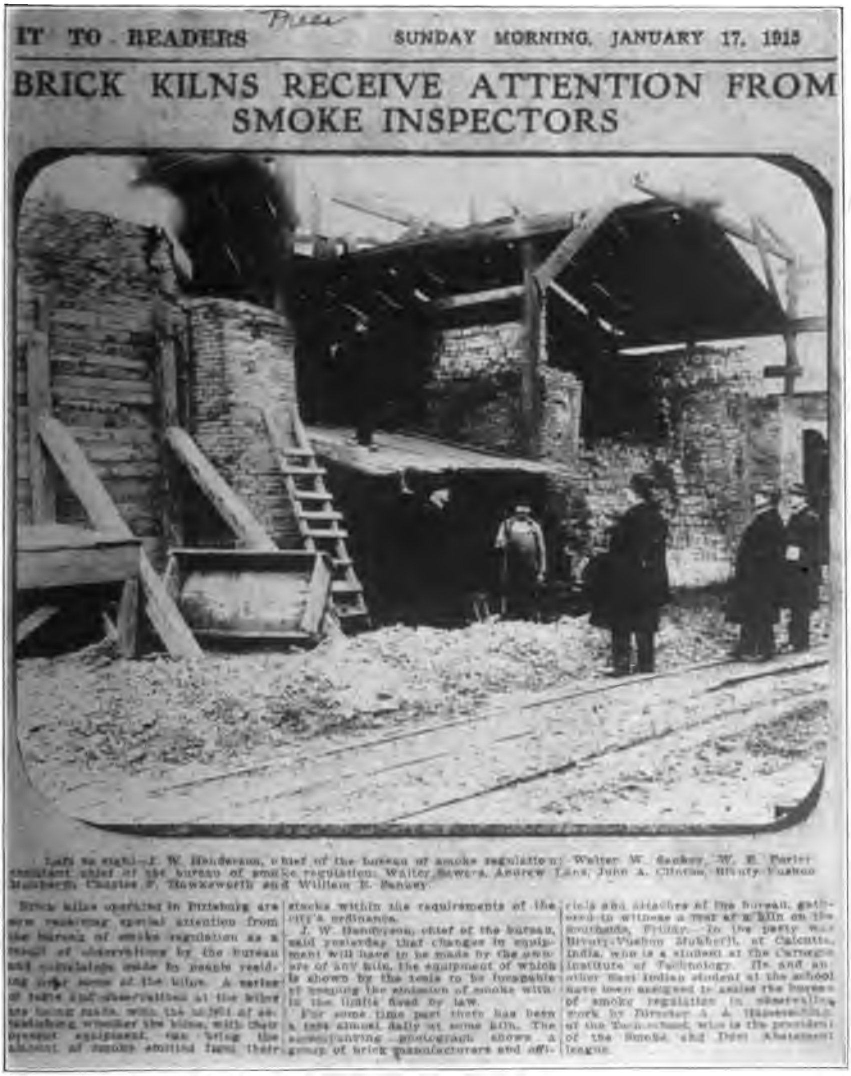
PITTSBURGH TO AID INVENTORS' PLANS TO LESSEN SMOKE

Plate 4

and our report of smoke abatement up to that time under the present regime.

Plate No. 5 speaks for itself in the heading, "Brick Kilns Receive Attention From Smoke Inspectors."

Plate No. 6 is copy of the call for the noon luncheon and meeting of the Chamber of Commerce, to hear an address on the subject, "Smoke Abatement and the Chamber of Commerce, a Duty." This talk was interspersed with reading of letters that had been sent the Bureau of Smoke Regulation. Some of these letters were from prominent philanthropic men who, as officers of well-known old-established concerns, wrote that



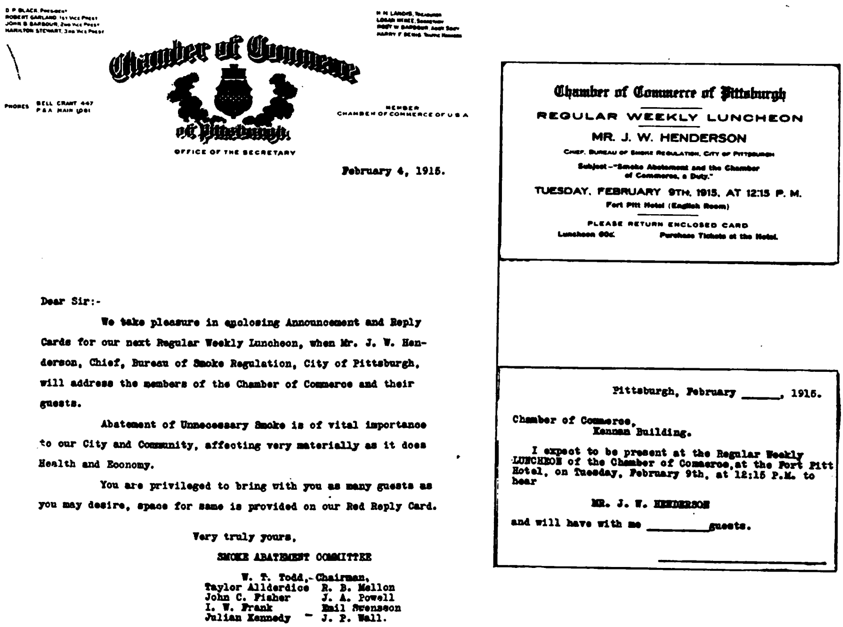
Press

IT TO READERS SUNDAY MORNING, JANUARY 17, 1915

BRICK KILNS RECEIVE ATTENTION FROM SMOKE INSPECTORS

Plate 5

our activity in the matter of smoke abatement was responsible for the removal of their plants from the city. Incidentally we should go on record here, that in not a single instance was this a true statement of the case. The interest aroused at this meeting culminated later in positive action of the Chamber of Commerce at a regular meeting, in passing resolutions of recommendations to the Bureau of Smoke Regulation. The principal paragraph of these resolutions appears in Plate No. 7.



D. P. BLACK, President
ROBERT GARLAND, 1st Vice Prest
JOHN B. BARBOUR, 2nd Vice Prest
HAMILTON STEWART, 3rd Vice Prest

H. H. LANDIS, Treasurer
LOGAN MCKEE, Secretary
ROBT W. BARBOUR, Asst Secy
HARRY F. BEHIG, Traffic Manager

Chamber of Commerce of Pittsburgh
OFFICE OF THE SECRETARY

PHONES BELL GRANT 447
P & A MAIN 1061

MEMBER
CHAMBER OF COMMERCE OF U S A

February 4, 1915.

Dear Sir:-

We take pleasure in enclosing Announcement and Reply Cards for our next Regular Weekly Luncheon, when Mr. J. W. Henderson, Chief, Bureau of Smoke Regulation, City of Pittsburgh, will address the members of the Chamber of Commerce and their guests.

Abatement of Unnecessary Smoke is of vital importance to our City and Community, affecting very materially as it does Health and Economy.

You are privileged to bring with you as many guests as you may desire, space for same is provided on our Red Reply Card.

Very truly yours,
SMOKE ABATEMENT COMMITTEE
W. T. Todd,-Chairman,
Taylor Allderdice R. B. Mellon
John C. Fisher J. A. Powell
I. W. Frank Emil Swensson
Julian Kennedy J. P. Wall.

Chamber of Commerce of Pittsburgh
REGULAR WEEKLY LUNCHEON
MR. J. W. HENDERSON
CHIEF, BUREAU OF SMOKE REGULATION, CITY OF PITTSBURGH
Subject—"Smoke Abatement and the Chamber of Commerce, a Duty."
TUESDAY, FEBRUARY 9TH, 1915, AT 12:15 P. M.
Fort Pitt Hotel (English Room)
PLEASE RETURN ENCLOSED CARD
Luncheon 60¢. Purchase Tickets at the Hotel.

Pittsburgh, February ______, 1915.

Chamber of Commerce,
Kennan Building.

I expect to be present at the Regular Weekly LUNCHEON of the Chamber of Commerce, at the Fort Pitt Hotel, on Tuesday, February 9th, at 12:15 P.M. to hear

MR. J. W. HENDERSON

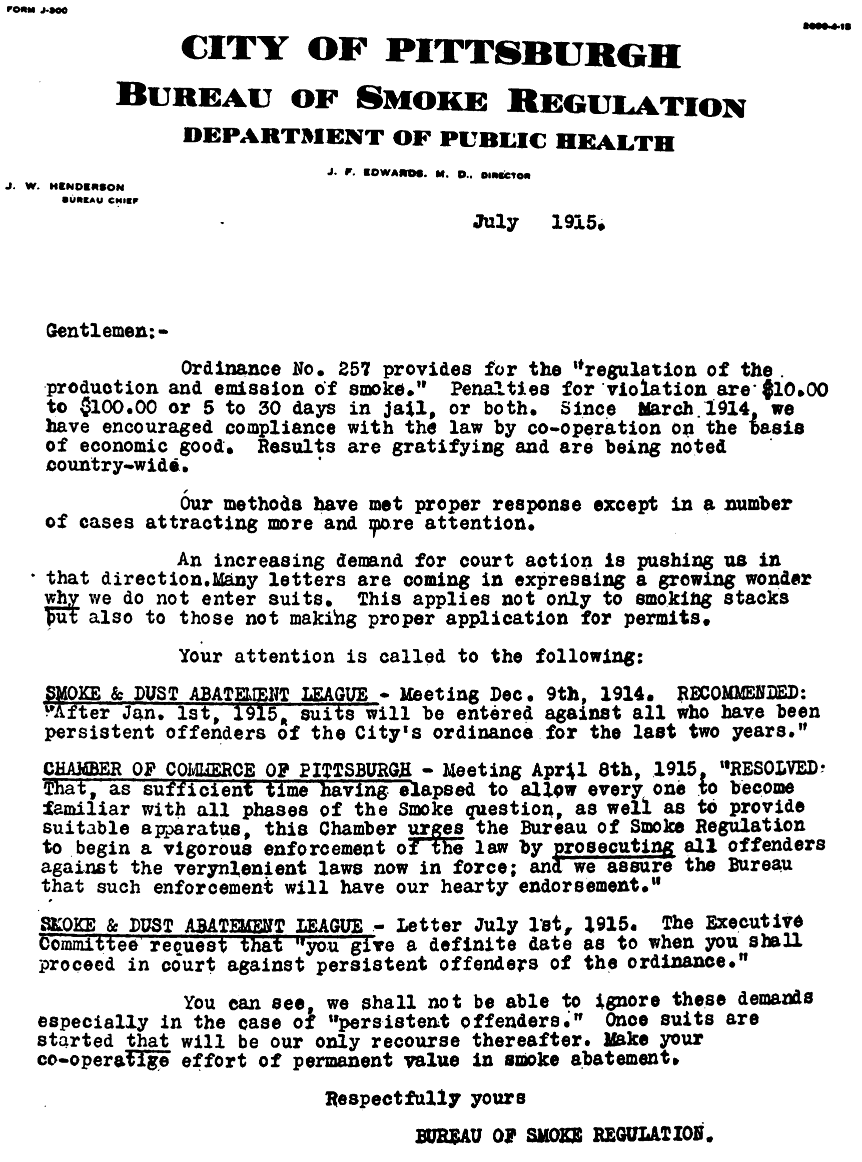
and will have with me __________ guests.

Plate 6

Plate No. 7 contains a copy of circular letter sent out to all concerns, calling attention to certain demands upon us for more drastic action against violators of the smoke ordinance. We shall read the letter.

(Here read the letter shown on Plate No. 7.)

Plates Nos. 8 and 9 show another means for securing publicity. Two pictures of locomotives were decorated with pieces of cards showing a cloud of smoke of number 3, Ringlemann Smoke Chart, and also number 1 of the same chart. These were thus descriptive of a violation of the ordinance and of the effect upon such smoke of the proper application of the locomotive stack blower. The other additions to the pictures are shown in this plate on the screen. The pictures from which these plates were taken were displayed at the Pittsburgh Exposition last September in the section where the city had its exhibit.



FORM J-300

2000-4-15

CITY OF PITTSBURGH

BUREAU OF SMOKE REGULATION

DEPARTMENT OF PUBLIC HEALTH

J. F. EDWARDS. M. D., DIRECTOR

J. W. HENDERSON
BUREAU CHIEF

July 1915.

Gentlemen:-

Ordinance No. 257 provides for the "regulation of the production and emission of smoke." Penalties for violation are $10.00 to $100.00 or 5 to 30 days in jail, or both. Since March 1914, we have encouraged compliance with the law by co-operation on the basis of economic good. Results are gratifying and are being noted country-wide.

Our methods have met proper response except in a number of cases attracting more and more attention.

An increasing demand for court action is pushing us in that direction.Many letters are coming in expressing a growing wonder why we do not enter suits. This applies not only to smoking stacks but also to those not making proper application for permits.

Your attention is called to the following:

SMOKE & DUST ABATEMENT LEAGUE - Meeting Dec. 9th, 1914. RECOMMENDED: "After Jan. 1st, 1915, suits will be entered against all who have been persistent offenders of the City's ordinance for the last two years."

CHAMBER OF COMMERCE OF PITTSBURGH - Meeting April 8th, 1915, "RESOLVED: That, as sufficient time having elapsed to allow every one to become familiar with all phases of the Smoke question, as well as to provide suitable apparatus, this Chamber urges the Bureau of Smoke Regulation to begin a vigorous enforcement of the law by prosecuting all offenders against the verynlenient laws now in force; and we assure the Bureau that such enforcement will have our hearty endorsement."

SMOKE & DUST ABATEMENT LEAGUE - Letter July 1st, 1915. The Executive Committee request that "you give a definite date as to when you shall proceed in court against persistent offenders of the ordinance."

You can see, we shall not be able to ignore these demands especially in the case of "persistent offenders." Once suits are started that will be our only recourse thereafter. Make your co-operatige effort of permanent value in smoke abatement.

Respectfully yours

BUREAU OF SMOKE REGULATION.

Bureau Chief.

Plate 7

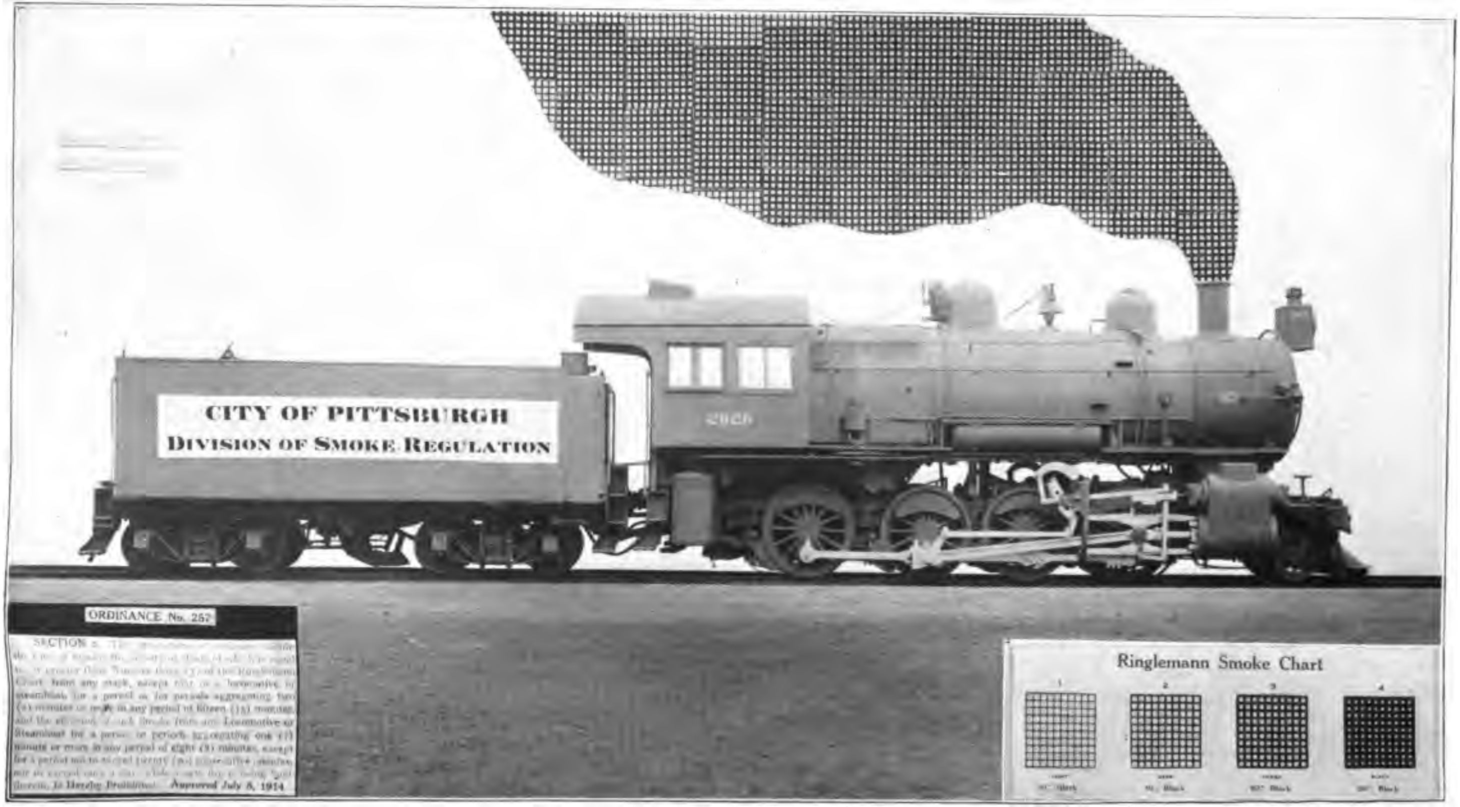

CITY OF PITTSBURGH
DIVISION OF SMOKE REGULATION
ORDINANCE No. 257
SECTION
Approved July 8, 1914
Ringlemann Smoke Chart
1
2
3
4
20% Black
40% Black
60% Black
80% Black

Plate 8

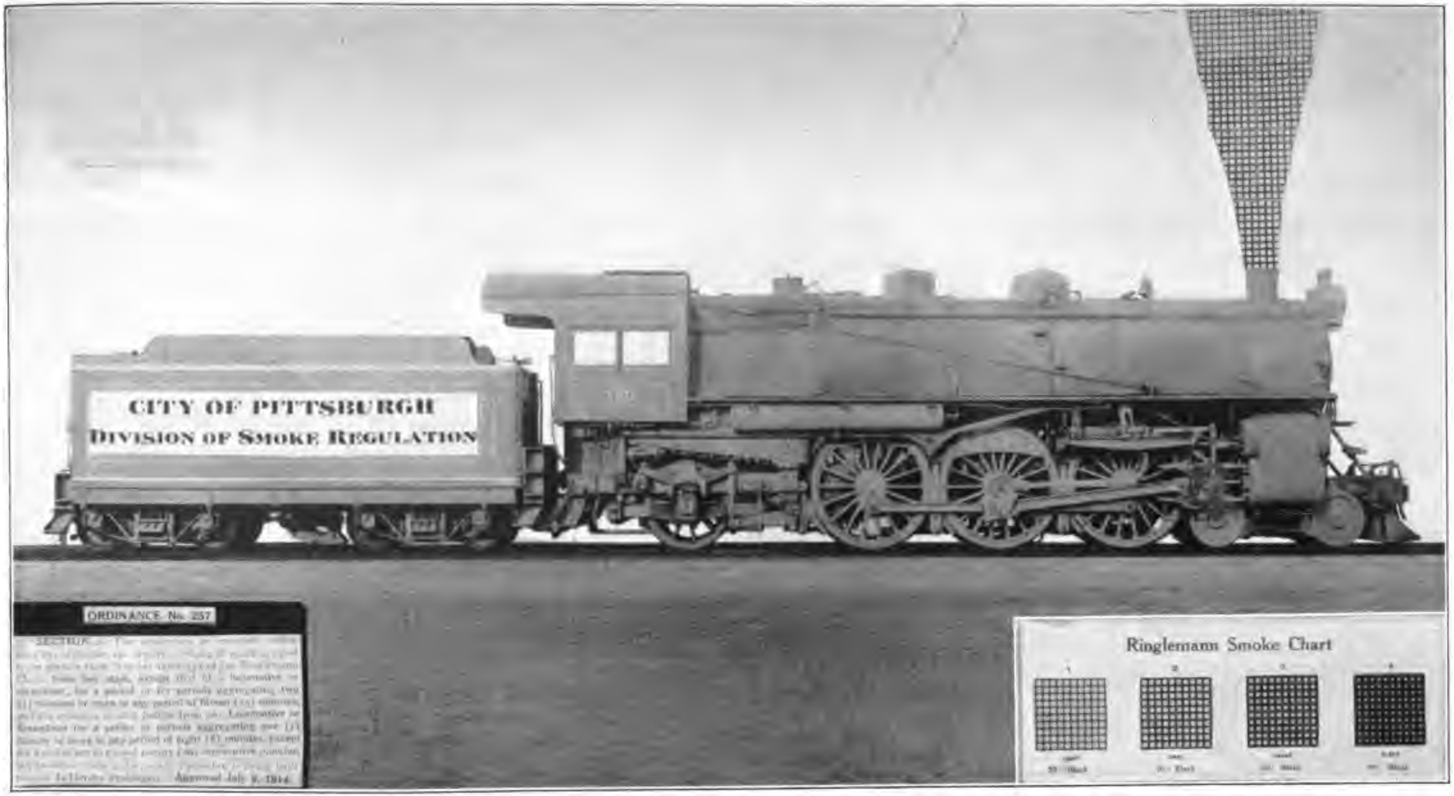

CITY OF PITTSBURGH
DIVISION OF SMOKE REGULATION
ORDINANCE No. 257
SECTION
Approved July 9, 1914
Ringlemann Smoke Chart
1
2
3
4
20% Black
40% Black

Plate 9

SMOKE & DUST ABATEMENT LEAGUE MEETING

Post 12/10/14

Two

SMOKE LEAGUE HEARS REPORTS

City Is Improving Atmospherically, Chief Henderson Declares.

MAY PUNISH VIOLATORS

[illegible]

WANTS CO-OPERATION

[illegible]

OFFICERS ELECTED

[illegible]

Gazette 12/10/14

Pittsburgh No Longer Smoky City

Ahead of Other Communities in Cleanliness of Atmosphere, Says Hamerschlag.

[illegible]

Need of Conference Wave

[illegible]

Officers Elected

[illegible]

Million Dollars Asked

Dispatch 12-10-14

WOULD FOSTER SMOKE CURES

League Resolves to Give All Inventors Encouragement to Clear Atmosphere

[illegible]

Pittsburgh's Smoke Being Abated

[illegible]

REAL ESTATE BOARD MEETING

Post 7-7-15

Smoke Much Diminished.

[illegible]

SMOKE PREVENTION WORK CONTINUES

[illegible]

WANTS WHITE BUILDINGS AS SMOKE BAROMETERS

Press

Chief Henderson Outlines Plan By Which He Hopes to Lessen Coal Smudge and Stimulate Civic Pride. Tries to Interest Clubs.

[illegible]

PALM BEACH SUITS

SMOKE GONE, CITIZENS ARE WEARING LIGHT SUITS

[illegible]

7-23-15

MORE WHITE SUITS BECAUSE LESS SMOKE, SAYS BUREAU

Smoke Prevention Officials Modestly Disclaim Any Ambition as Arbiters of Fashion, But They Proudly Point to the Palm Beach Togs as Evidence That They Have Been on the Job.

[illegible]

Press 7/23/15

Less Smoke; More Light Clothes

[illegible]

Gazette 7-21-15

Clothiers Say Smoke Report Is Justified

More Suits of Light Shades Sold This Year Than Ever Before Despite Unseasonableness.

[illegible]

Post 7/24/15

THIS SETTLES IT.

[illegible]

POWDERED COAL

Sun 5/17/15

No More Smoke.

The International Railway Fuel Association is to meet in Chicago this week and will discuss the question of conservation of the fuel supply by means of complete combustion. [illegible]

[illegible]

G 10-28-14

[illegible]

Post 12/4/15

[illegible]

20TH CENTURY CLUB.

Post 12/15

[illegible]

Twentieth Century Club.

[illegible]

Women's Club of Oakland.

[illegible]

ADVISORY BOARD

Smoke Expert Appointed.

[illegible]

Gazette 1/9/14

CHAMBER OF COMMERCE

DUTY COMMISSION ENDORSE.

The approval given by the Chamber of Commerce to the suggestion that the chief of the bureau of smoke regulation prosecute persistent offenders against the smoke ordinance is [illegible]

Post 4/9/15

Press FRIDAY

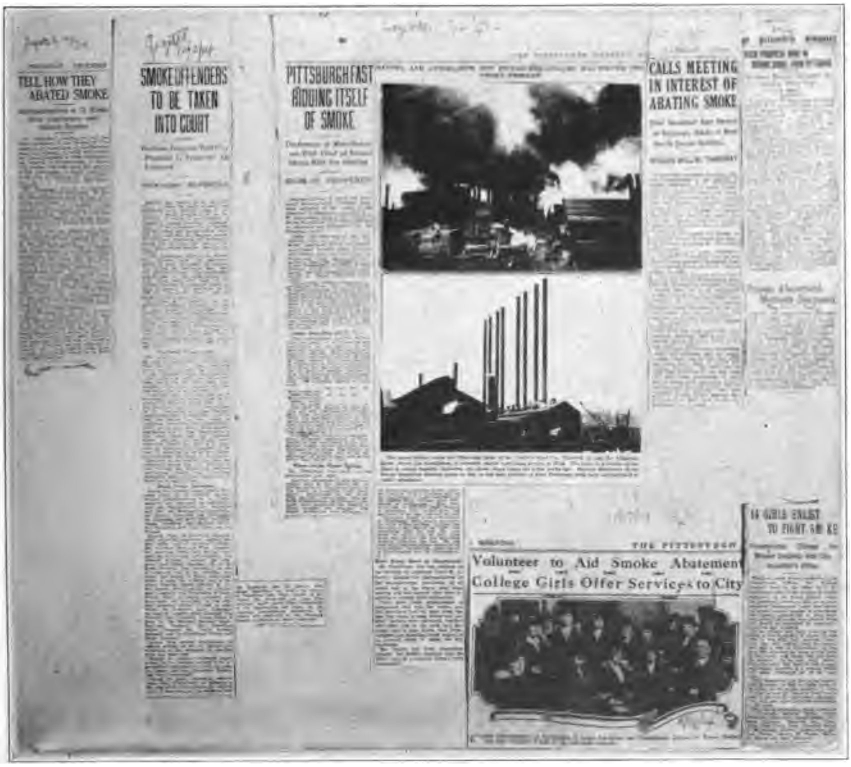
SMOKE NUISANCE BEFORE CHAMBER

Trade Body Wants Offenders Against the Municipal Ordinance Prosecuted.

The Pittsburgh Chamber of Commerce [illegible]

Plate No. 10 contains clippings having interesting headings. Attention is directed to the following: "Smoke League Hears Reports," "Would Foster Smoke Cures," "Pittsburgh No Longer Smoky City," and "More White Suits Because Less Smoke, Says Bureau." This last is worth reading, especially as the clipping below it on the screen states that "Clothiers Say Smoke Report Is Justified."

Plate No. 11 has reference to reports in the daily papers of several meetings and also in regard to a number of young ladies from the Pennsylvania College for Women visiting the smoke office to discuss ways and means by which they might assist in smoke abatement.



TELL HOW THEY ABATED SMOKE

SMOKE OFFENDERS TO BE TAKEN INTO COURT

PITTSBURGH FAST RIDDING ITSELF OF SMOKE

CALLS MEETING IN INTEREST OF ABATING SMOKE

THE PITTSBURGH

Volunteer to Aid Smoke Abatement

College Girls Offer Services to City

14 GIRLS ENLIST TO FIGHT SM KE

Plate 11

Plates Nos. 12 and 13 are views of the city of Pittsburgh from a point half way up one of the inclines to Mt. Washington. No. 12 is a sample of Smoky Pittsburgh as it was all too frequently, especially whenever the wind velocity was below 8 miles an hour and the humidity was high. No. 13 is the same view taken 7 minutes after No. 12, when the outlines of the buildings begin to appear as a result of an increase in

Plate 13

wind velocity. Both were taken May 20, 1914, when we had four dark days due to dense smoke and fog. There has not been a repetition of this occurrence for even a single day since May, 1914.

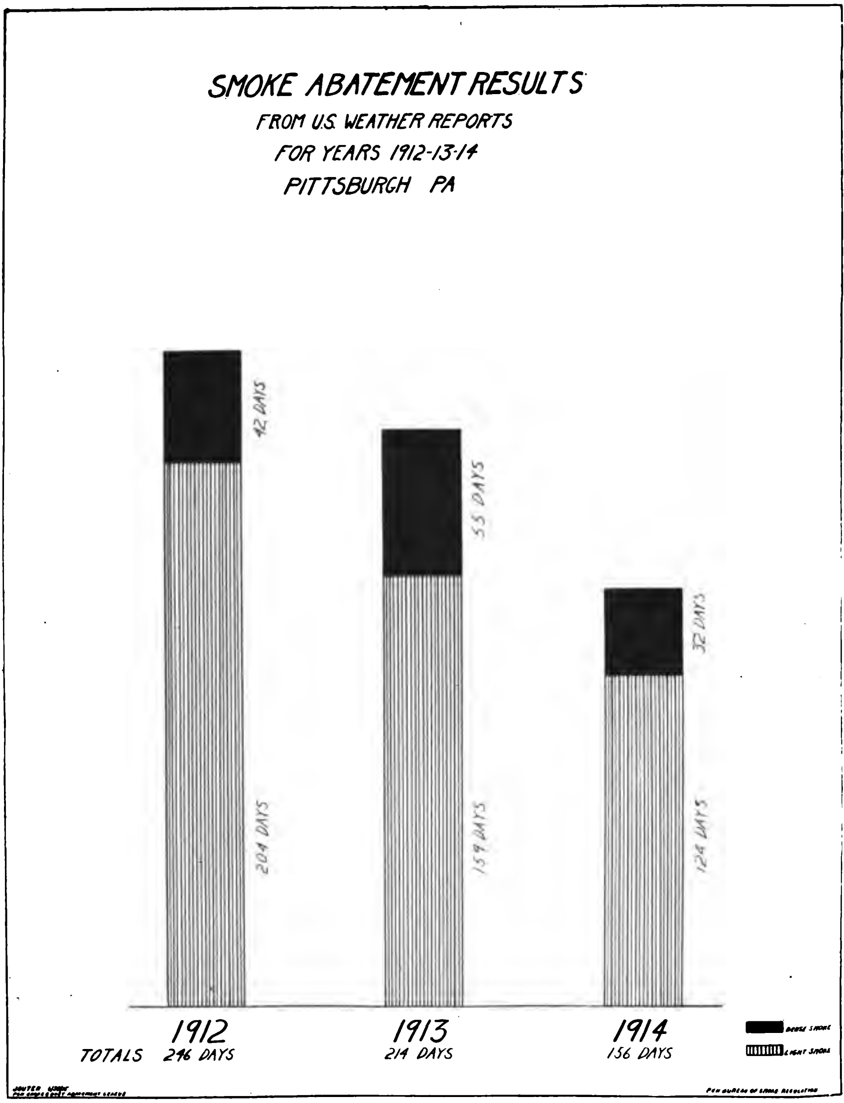


Plate 14

Plates 14 and 15 are proof of the statement just made in the last sentence above. These are diagrams made up from the records of the Pittsburgh Office of the United States Weather Service. These charts were made up in time for our last meeting, July 1st. The best newspaper report of that meeting was shown in Plate No. 11 and therein appeared the records shown in these charts. The diagrams show 246 days light and dense smoke recorded for 1912, 214 for 1913 and 156 for 1914. For the first half of the same years and 1915, the figures are: 1st six months 1912, 123 days; 1913, 105 days; 1914, 76 days, and 1915, 67 days.

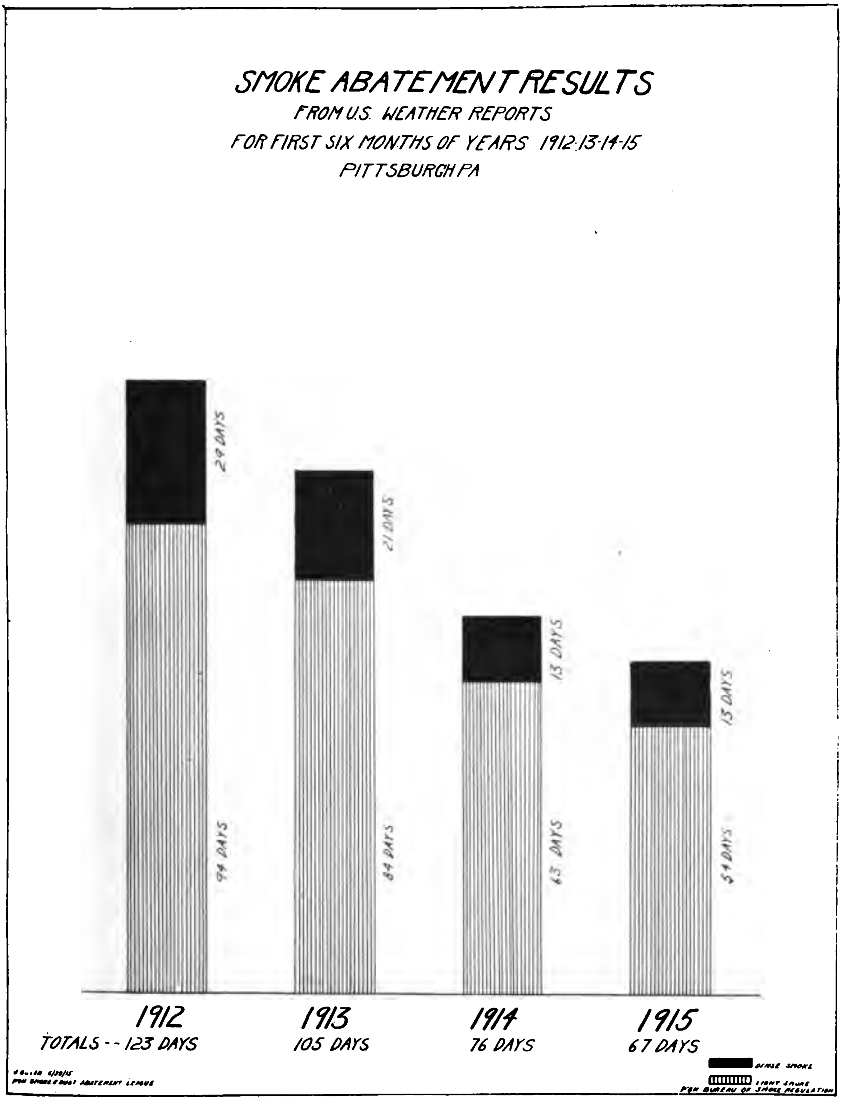
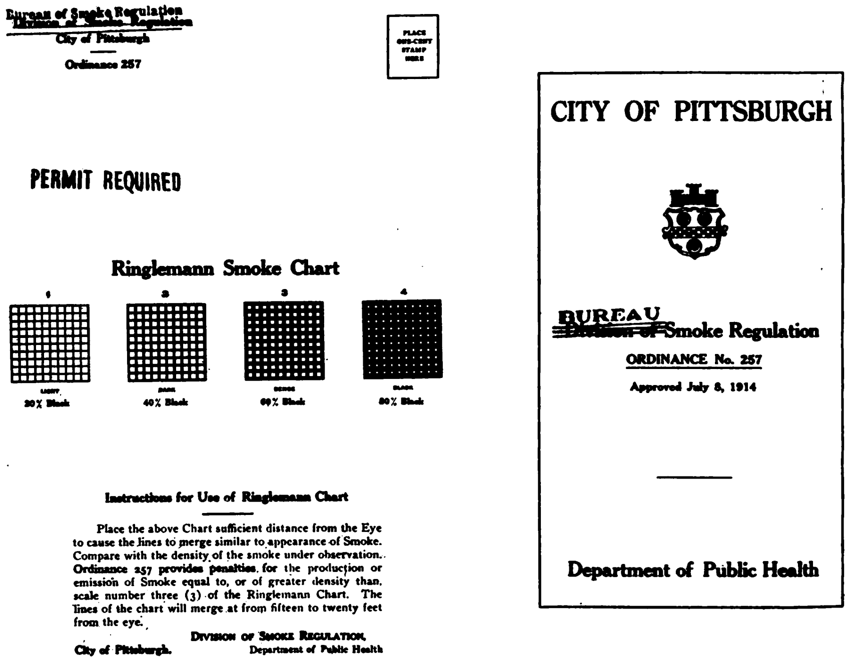


Plate 15

Plate No. 16 is from the cover of the printed copies of the last smoke ordinance for general distribution, under one-cent postage, using a clip and arranged to be folded so that the Ringlemann Chart is on the opposite side from the address. Below the chart are instructions for using the same and on the inside back cover, but not shown on this plate, are instructions for firing boiler furnaces.



Bureau of Smoke Regulation
~~Division of Smoke Regulation~~
City of Pittsburgh
Ordinance 257

PLACE
ONE-CENT
STAMP
HERE

PERMIT REQUIRED

Ringlemann Smoke Chart

1	2	3	4
LIGHT	DARK	DENSE	BLACK
20% Black	40% Black	60% Black	80% Black

Instructions for Use of Ringlemann Chart

Place the above Chart sufficient distance from the Eye to cause the lines to merge similar to appearance of Smoke. Compare with the density of the smoke under observation. **Ordinance 257 provides penalties** for the production or emission of Smoke equal to, or of greater density than, scale number three (3) of the Ringlemann Chart. The lines of the chart will merge at from fifteen to twenty feet from the eye.

DIVISION OF SMOKE REGULATION,
City of Pittsburgh. Department of Public Health

CITY OF PITTSBURGH

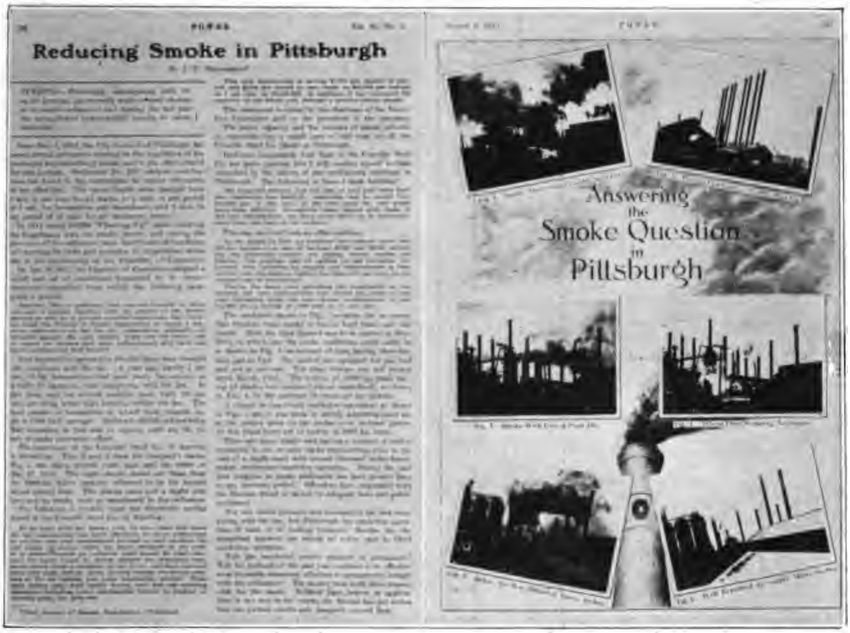
BUREAU
~~Division of~~ Smoke Regulation
ORDINANCE No. 257
Approved July 8, 1914

Department of Public Health

Plate 16

Plate No. 17 is taken from "Power." It shows one page of printed matter under the heading "Reducing the Smoke in Pittsburgh," and on the opposite page photographs of power plants as they used to operate in violation of the law and as they have been changed. The page of photographs is titled "Answering the Smoke Question in Pittsburgh."

Plate No. 18 indicates the interest a progressive department store in our city takes in the matter of smoke abatement. In the window are the original photographs mentioned in Plate No. 17, a copy of "Power," which is behind the young men in a stooping posture, and also a copy of the reprint from "Power."



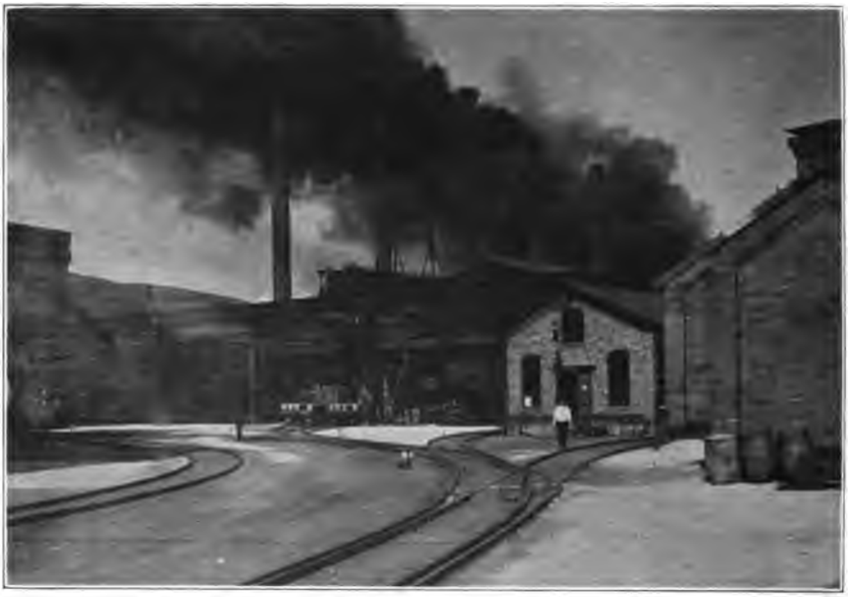
POWER

Reducing Smoke in Pittsburgh

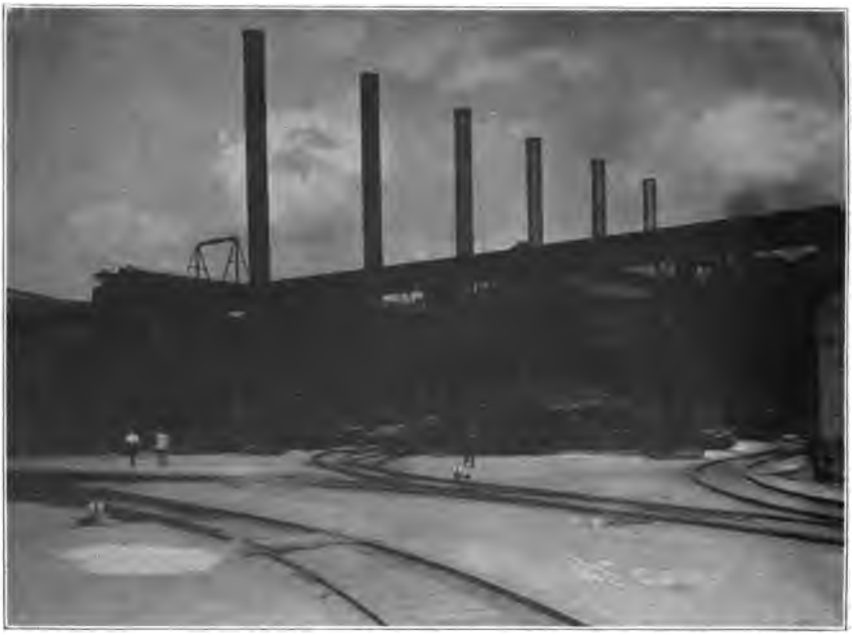
Answering the Smoke Question in Pittsburgh

Plate 17

Plate 18



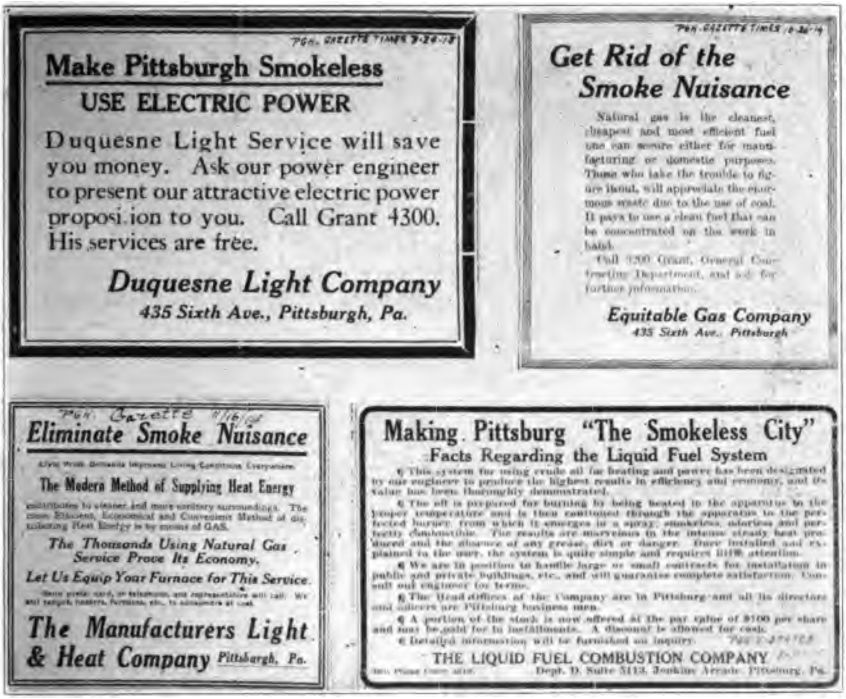
National Tube Company Plant, McKeesport, Pa., Before Installation of Underfeed Stokers.



National Tube Company Plant, McKeesport, Pa., After Installation of Underfeed Stokers, Operating at Capacity.

Plate 19

Beginning with Plate No. 19, we come to some things indicating the value of publicity. No. 19 contains views before and after the installation of Underfeed Stokers at the McKeesport Plant of the National Tube Company. The photographs were taken when the boilers were operating above rating. This plate is shown because the stokers were required to cause the stacks to meet the requirements of the Pittsburgh Smoke Ordinance, and incidentally to indicate the possibilities of smoke abatement and experience great economies at the same time.



PGH. GAZETTE TIMES 9-24-13

Make Pittsburgh Smokeless

USE ELECTRIC POWER

Duquesne Light Service will save you money. Ask our power engineer to present our attractive electric power proposition to you. Call Grant 4300. His services are free.

Duquesne Light Company
435 Sixth Ave., Pittsburgh, Pa.

PGH. GAZETTE TIMES 10-26-14

Get Rid of the Smoke Nuisance

Natural gas is the cleanest, cheapest and most efficient fuel one can secure either for manufacturing or domestic purposes. Those who take the trouble to figure it out, will appreciate the enormous waste due to the use of coal. It pays to use a clean fuel that can be concentrated on the work in hand.

Call 1200 Grant, General Contracting Department, and ask for further information.

Equitable Gas Company
435 Sixth Ave., Pittsburgh

Pgh. Gazette 4/16/13

Eliminate Smoke Nuisance

[illegible]

The Modern Method of Supplying Heat Energy

contributes to cleaner and more sanitary surroundings. The most Efficient, Economical and Convenient Method of distributing Heat Energy is by means of GAS.

The Thousands Using Natural Gas Service Prove Its Economy.

Let Us Equip Your Furnace for This Service.

Send postal card, or telephone, and representative will call. We sell ranges, heaters, furnaces, etc., to consumers at cost.

The Manufacturers Light & Heat Company Pittsburgh, Pa.

Making Pittsburg "The Smokeless City"

Facts Regarding the Liquid Fuel System

¶ This system for using crude oil for heating and power has been designed by our engineer to produce the highest results in efficiency and economy, and its value has been thoroughly demonstrated.

¶ The oil is prepared for burning by being heated in the apparatus to the proper temperature and is then continued through the apparatus to the perfected burner, from which it emerges in a spray, smokeless, odorless and perfectly combustible. The results are marvelous in the intense steady heat produced and the absence of any grease, dirt or danger. Once installed and explained to the user, the system is quite simple and requires little attention.

¶ We are in position to handle large or small contracts for installation in public and private buildings, etc., and will guarantee complete satisfaction. Consult our engineer for terms.

¶ The Head Offices of the Company are in Pittsburg and all its directors and officers are Pittsburg business men.

¶ A portion of the stock is now offered at the par value of $100 per share and may be paid for in installments. A discount is allowed for cash.

¶ Detailed information will be furnished on inquiry.

THE LIQUID FUEL COMBUSTION COMPANY

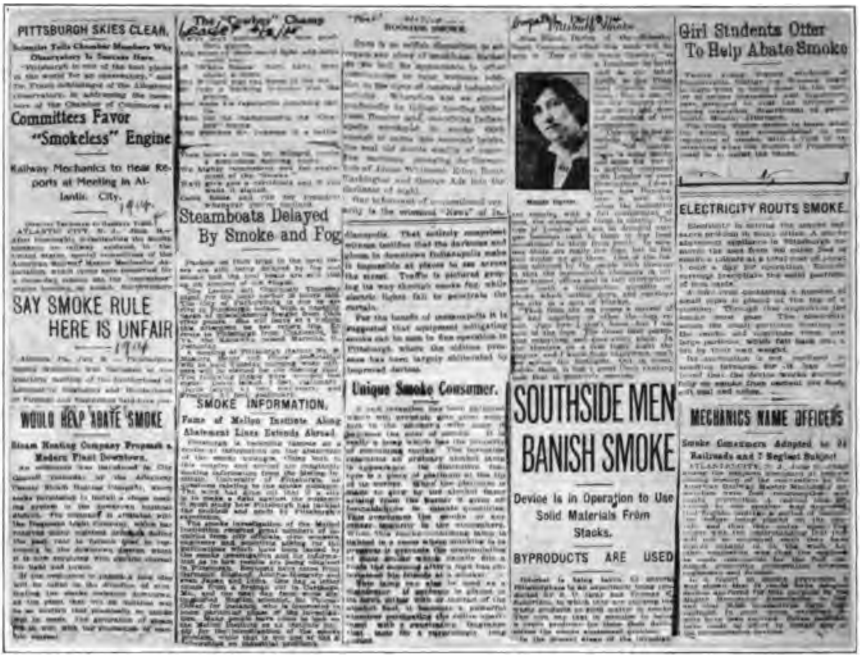
[illegible] Dept. D. Suite 5113, Jenkins Arcade, Pittsburg, Pa.

Plate 20

Plate No. 20 proves the public interest taken in smoke abatement. Here are shown cases where advertisers of wide experience took advantage of this interest to attract attention to what they had to sell on the basis of merit toward forwarding the smoke abatement movement.

Plate No. 21 has photographs of clippings covering various interesting sidelights on the smoke and smoke abatement question. Here are references to the investigations of the Mellon Institute of Industrial Research; the smoke question before the convention of the American Railway Master Mechanics at Atlantic City; steamboats delayed by smoke and fog; a statement of comparison between the smoky condition of

English cities and Pittsburgh, by an actress of note; and also other things of more or less value. Not the least of these clippings is the verse showing smoke has attained to poetic value, in the piece headed "The 'Cowboy' Champ."



PITTSBURGH SKIES CLEAN.

Committees Favor "Smokeless" Engine

Railway Mechanics to Hear Reports at Meeting in Atlantic City.

1914

SAY SMOKE RULE HERE IS UNFAIR

1914

WOULD HELP ABATE SMOKE

Steam Heating Company Proposes a Modern Plant Downtown.

The "Cowboy" Champ

Steamboats Delayed By Smoke and Fog

SMOKE INFORMATION.

Fame of Mellon Institute Along Abatement Lines Extends Abroad.

Unique Smoke Consumer.

SOUTHSIDE MEN BANISH SMOKE

Device Is in Operation to Use Solid Materials From Stacks.

BYPRODUCTS ARE USED

Girl Students Offer To Help Abate Smoke

ELECTRICITY ROUTS SMOKE

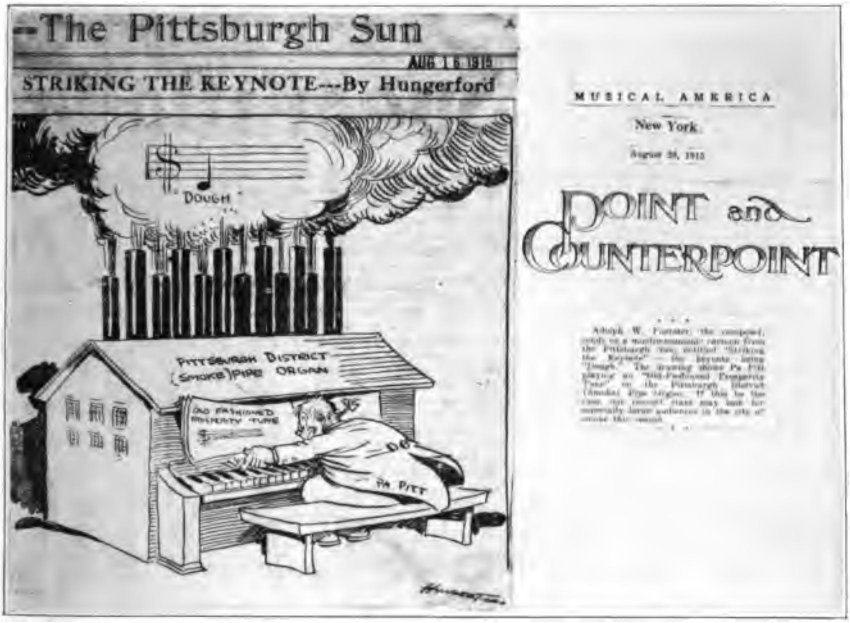
MECHANICS NAME OFFICERS

Plate 21

Plate No. 22 is quite a departure from all the others. On the one side is shown the "Pittsburgh District (Smoke) Pipe Organ," indicating the stacks are again all active and that "Dough" is with us once more, while on the other, and taking advantage of this notice, of busy mills being again in evidence. Musical America congratulates the musical stars on this evidence foreshadowing large audiences in Pittsburgh. Musical America did not notice that the artist shows all the stacks but one operating with smoke emission within the law.

Plate No. 23, last but not least, is of the latest electric sign above the boulevard and near Union Station, in Pittsburgh. The arms of electric light appear to turn the switch and first throw on the sign, "Make Pittsburgh Smokeless." Other motions are made and the balance of the sign flashes into sight.

From what has been said and from the views shown, you will draw



The Pittsburgh Sun

AUG 16 1915

STRIKING THE KEYNOTE---By Hungerford

"DOUGH"
PITTSBURGH DISTRICT (SMOKE) PIPE ORGAN
OLD FASHIONED PROSPERITY TUNE
PA PITT
HUNGERFORD

MUSICAL AMERICA

New York

August 28, 1915

POINT and COUNTERPOINT

Plate 22

Plate 23

your own conclusions. The particular value of it all is its effect upon those responsible for violations of the smoke ordinance.

There was a time when newspapers and other publications would not give space to any phase of the question. In some few cases this was because of the fear of losing patronage by giving offense to especially the larger interests responsible for most of the smoke. The principal reason, though, was because the audience was not at hand.

Publicity bears the same relation to smoke abatement that advertising does to businesses which depend upon the general public for profit. The space devoted to both is significant of their success. The newspaper people in particular know what the people want to know and how they want it presented. A direct statement that you might consider of moment to you, such as "John Smith has put in a smoke consumer and cleaned up his stack," might be good news to John's next-door neighbor in the mill district, but to the fellow out in the residential section it means very little. There is nothing in the statement that touches his personal life or that of his family.

We must be right ourselves and appeal to the same human quality in others. The work must be put on the same plane as the best intelligence, responsible for the conditions to be corrected and in the community who are interested in the movement. One's personality must be kept in the background while the work itself must always be kept in the forefront. Each individual is a possible center for publicity and an opportunity to disseminate correct information in regard to smoke abatement.

Credit must be given freely to every one who helps the good work along. In this way all those who desire the welfare of their fellow beings and themselves are co-ordinated into a force which cannot and which will not be ignored by even the most selfish and thoughtless.

The results from it all in Pittsburgh during the last year and a quarter have proven that smoke abatement "Can Be Done"; that it is "Worth While Doing," and that the accomplishment of compliance with the law regulating the production and emission of smoke is *only a matter of engineering and experience.*

What is of equal importance is the ability to obtain and the opportunity for securing the attention and good will of the public, the civic organizations and the newspapers and bringing about the co-operation of all involved.

In this case it has been easier to do the thing than it is to tell even one person how it should best be done.

J. W. HENDERSON,
Bureau Chief.

THIRD SESSION—THURSDAY MORNING, SEPT. 9, 1915.

The Convention met pursuant to adjournment promptly at 9:00 a. m. Pres. Towner in Chair.

The first paper on the program this morning is "Smokeless Locomotive Operation Without Special Apparatus," by H. H. Maxfield, M. M., Pennsylvania Railroad, Pittsburgh, Pa.

H. H. **Maxfield**, M. M., Pittsburgh, Pa.: Mr. President and Gentlemen, before reading what little I have to say on this subject, I would like to mention that the subject of the paper is not of my own choosing, it is in the nature of a hand-out by the Committee in charge of this convention. Probably if I had selected my own subject I would have modified the title a little bit.

I do not claim, and I do not believe any railroad man would claim, the possibility of the absolute elimination of smoke from locomotives burning bituminous coal. The best we can do is to approach it under certain conditions and with certain restrictions; and the nearer, of course, that we approach it, the better it is not only for ourselves, but for the residents of the territory through which we operate.

Mr. Maxfield then proceeded with his paper, viz.:

SMOKELESS LOCOMOTIVE OPERATION WITHOUT SPECIAL APPARATUS.

H. H. MAXFIELD, MASTER MECHANIC, PENNSYLVANIA RAILROAD CO.,
PITTSBURGH, PA.

The President and Members of the International Association for the Prevention of Smoke:

The problem of eliminating objectionable smoke from steam locomotives is naturally divided into two parts; first, Terminal, or Engine House Operation, and second, Road Operation. Probably the more vital of the two is the Engine House Operation, for the reasons that, due to the cleaning and rebuilding of fires, a large amount of objectionable smoke is apt to be produced; and furthermore, the success of the road operation depends very largely on the condition of the locomotive, especially its fire, when it is turned over to the crew by the engine house organization.

Again, a locomotive is hours at the engine house to minutes in the smoke restricted district while in charge of the crew.

If, therefore, the elimination of objectionable smoke can be accomplished at engine terminals, and the locomotives turned over to the crews with fires in such a condition that it is not necessary to do much in the way of heavy firing while passing through the restricted area, the problem is more than half solved.

We will consider: First, The Terminal Problem, and second, The Road Problem.

THE TERMINAL PROBLEM.

The first essential is that the locomotive be delivered by the crew at the ashpit with the fire in good condition, i. e., not badly burnt out nor yet full of green coal, but having a medium-sized, bright fire. This allows of the cleaning and banking of same with a minimum of smoke. It is obvious that a nearly-burnt-out fire requires a large amount of coal to rebuild same, thus increasing the liability of objectionable smoke; while

Shavings Used for Starting Fires

in the case of a heavy, green fire, the coal is already present, making it very difficult to clean the fire without excessive smoke.

The second essential is the careful cleaning and rebuilding of fires and banking of same in case the locomotive is to remain at the terminal for any length of time. These operations being completed, the locomotive is moved to the engine house or storage yard, and from then on until the crew assumes charge, the burden is on the Engine Watcher, who must see that the fire is properly maintained until the crew assumes charge. It may be proper to say right here, however, if the fire is properly cleaned, rebuilt and banked, the Engine Watcher has a comparatively simple problem confronting him.

The third essential is the proper preparation of the fire for service by the Fireman upon taking charge of the locomotive. The first and second essentials having been properly taken care of, here again the problem is not difficult.

Without going into details, the methods of cleaning, building up, banking and the building of new fires as practiced at our engine terminals located within the limits of the city of Pittsburgh, are the result of a great deal of study and experimentation on the part of those in charge, including visits to terminals in other cities where the problem has been successfully handled, notably Washington, D. C. The instructions covering same follow:

RULES AND REGULATIONS FOR CLEANING AND BUILDING FIRES IN LOCOMOTIVES.

Black smoke shall not be made.

Cleaning Fires.

When cleaning fires at the ashpits, the blower shall be used with sufficient strength to keep down black smoke.

One-half of the fire shall be cleaned at a time. After the ashes are knocked out over one-half of the grate surface, this grate surface should then be covered with gas coal, and a layer of low volatile coal placed over this. The good fire should then be thrown over this coal to allow cleaning of the other half of the grate. After this half of the grate has been cleaned, it should be covered with a similar amount of gas and low volatile coal, and the burning fuel on the opposite side pulled over it until an even depth of fire is obtained over the entire grate surface.

If more coal is then needed to build up fire, Hostler shall use only low volatile coal, which has been thoroughly wet with water.

Ash Pits—Locomotives Having Fires Cleaned

Banking Fires.

All coal used for this purpose shall be low volatile coal, and shall be thoroughly wet with water.

Banking shall be started at rear end of firebox and built forward until fire has been covered within two or three feet of the front flue sheet.

The fire shall be heaviest along the side sheets and of minimum depth in the center.

In case a banked fire needs more coal supplied, low volatile coal shall be used exclusively. If there is no low volatile coal on the tender, Hostler shall make report of this condition to the Engine House Foreman and receive instructions.

Building Fires.

The entire surface of the grate shall be covered with three inches (3″) of gas coal spread over evenly, and upon this an even layer of four (4″) or five inches (5″) of low volatile coal thoroughly wet. Extreme care shall be used to see that the coal is spread evenly so as to cover the entire grate surface, and no holes should be left in it. Dry shavings shall be distributed over the entire surface of the coal, care being taken that the shavings shall be placed along the side sheets of the firebox. One bucket of shavings, which has been mixed with one quart of fuel oil, shall be evenly distributed on top of the dry shavings. When this has been done, the shavings should then be ignited by a small piece of waste thrown into the middle of the firebox. Blower should then be operated very lightly until the coal shall have become ignited, when the strength of the blower should be increased gradually.

Near View of Locomotive Having New Fire Built

The door shall be kept wide open when fire is started, but after the coal has become thoroughly ignited, door may be closed, depending upon smoke conditions at the stack.

Under no circumstances shall the fire be hooked.

If more coal should be needed, wet low volatile coal shall be supplied, but in small quantities.

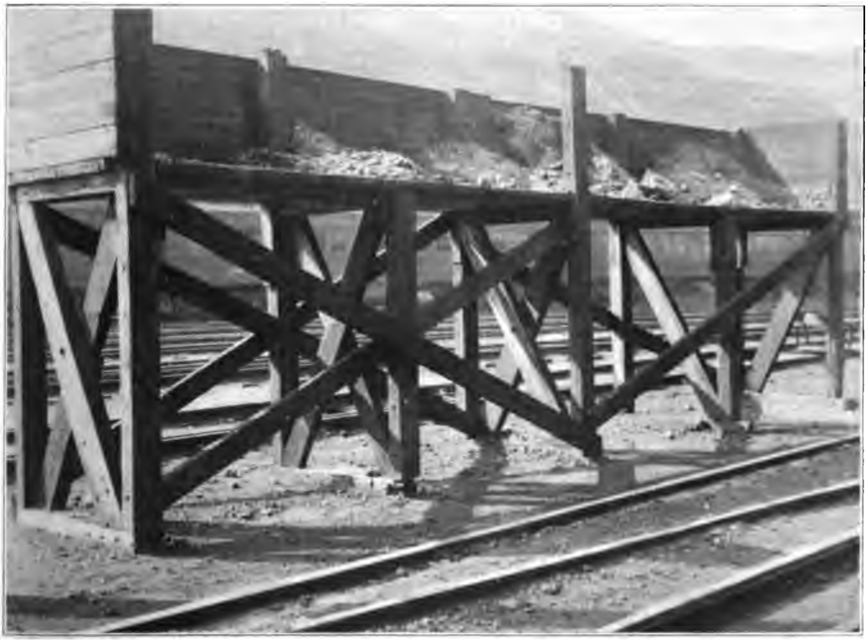
House blower shall not be used if locomotive in which fire is being built has fifty (50) pounds steam pressure.

When steam pressure reaches fifty (50) pounds on locomotive in which fire is being built, house blower shall be disconnected.

The use of low volatile coal is to be noted. This coal contains approximately from twenty (20) to twenty-two (22) per cent of volatile matter. The use of this coal, while not essential to the operation of locomotives at a terminal without objectionable smoke, is unquestionably a great aid, especially at congested points where it is necessary to handle a large amount of power in a minimum of time, and we feel fortunate, therefore, in that we are enabled to make use of same in working out this problem.

Five Locomotives Having New Fires Built

The placing of a layer of gas coal on the grates under the low volatile coal, when building new fires, as well as when cleaning fires, is an expedient for preventing the low volatile coal, due to its fineness, dropping into the ashpans, thus avoiding the necessity for a second cleaning of same. As the fire ignites from the top down, the volatile matter from the gas coal is ignited and consumed before passing out of the firebox.



Low Volatile Coal Platform

Wetting Low Volatile Coal While Being Put on Tender

The wetting of the coal is an expedient that has given excellent results from a smoke prevention standpoint and has not produced any injurious result.

In order to place low volatile coal on the tender, so that it will be accessible, special chutes were installed on the coal wharf, and in order that a limited supply may be accessible when needed, small platform bins have been erected at convenient points so that the Hostler can obtain same practically without getting off the locomotive. The low volatile chutes on the wharf have been equipped with sprinkler pipes, so that the coal is wetted as it flows into the tender.

The Men Behind the "Shovel"

Our method of banking fires not only eliminates, to a large extent, objectionable smoke, but it also enables us to turn the locomotive over to the engine crew with a heavy, bright fire, which requires very little working on the part of the Fireman, and this enables him to avoid objectionable smoke.

Our 28th Street, Pittsburgh, engine terminal handles, on an average, 175 locomotives in twenty-four (24) hours. Approximately thirty-five (35) new fires are built daily, about seventy-five per cent (75%) of them being built out of doors. An average of one hundred (100) engines per day have their fires cleaned or built at this point.

During the months of June and July, 1915, there were 403 observations taken at this point of the smoke conditions of locomotives having new fires built in same, and in these observations but eight cases of smoke of No. 3 or greater density were noted. In none of these cases did this grade of smoke extend over one or two minutes, which is well within the requirements of the ordinance.

Since January 1, 1915, no cases of objectionable smoke have been reported at our 28th Street terminal by the Bureau of Smoke Regulation. In order to keep the engine crews keyed up to the necessity of bringing locomotives to the ashpits with the fires in good condition, the Head Hostler examines practically all the fires of incoming locomotives and reports to the Engine House Foreman all cases where the fire is not up to the standard. These cases are referred to the Road Foreman of Engines for investigation and such action as may be necessary to prevent a repetition. In addition to this, the Smoke Inspector located at this point makes an average of about eighty-five (85) observations daily of smoke conditions, which are forwarded to the Master Mechanic and Road Foreman of Engines. This Inspector also devotes a large portion of his time to instructing Hostlers and Firemen in the proper methods of doing their work.

Engine Storage Yard—35 Locomotives

THE ROAD PROBLEM.

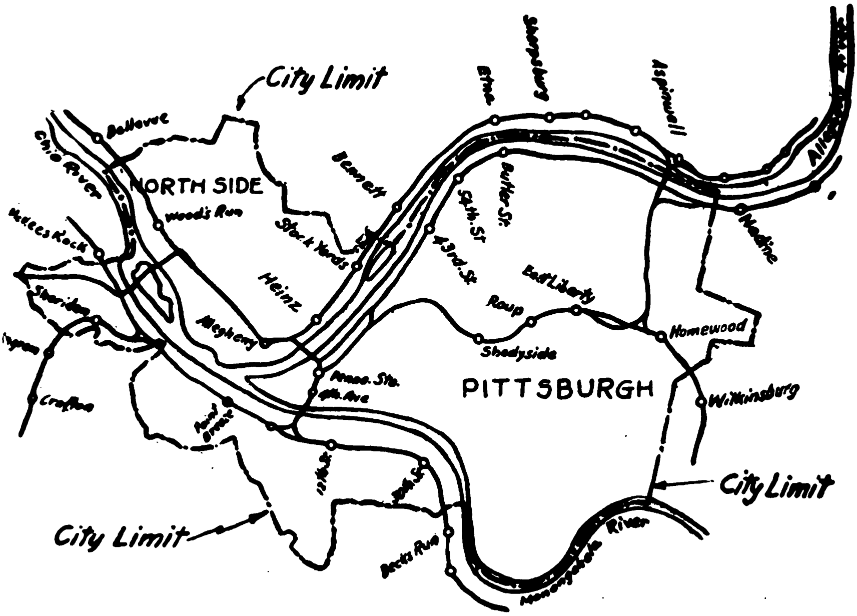
You are all undoubtedly more or less familiar with the topography of the country in which the city of Pittsburgh is situated and which seriously complicates the problem of smoke regulation. It will not be amiss at this point, however, to quote from Bulletin No. 8, "Smoke Investigation," by Mellon Institute of Industrial Research, School of Specific Industries, in which is set forth some "Engineering Phases of Pittsburgh's Smoke Problem":

"The topography of the city affects materially the operating conditions of the railroads and complicates the problems of smoke elimination. The various terminals of the railroads are situated not far from the junction of the two rivers and at comparatively low levels. Practically all trains leaving the city and going eastward are required to ascend heavy grades and pull around sharp or long, sweeping curves. It is necessary to exert a heavy pull from the time a train starts until it has passed beyond the city limits. This necessitates heavy firing and is responsible for a large amount of smoke and cinder. All the roads leaving the city have their tracks along the base of hills or in valleys between the hills. The contour of the district is such that there is a tendency to pocket the

Engine House—18 Locomotives Under Steam

smoke and cinder in the valleys, or deposit them over residential sections immediately overlooking the same. Residents located on the top of the hills suffer heavily from the smoke made by locomotives in the river valleys. In every case where a railroad passes a city park the grades are steep for out-going trains. This calls for heavy firing and very often the aid of a pusher locomotive to help freight trains over these grades."

By referring to a map it will be noted that the Pennsylvania Railroad and its subsidiary lines pretty completely cover the city. Starting from Pennsylvania Station as a center, the Pittsburgh Division extends east



through Shadyside, Roup, East Liberty and Homewood, passing out of the city limits west of Wilkinsburg, a distance of six miles over a generally ascending grade, the maximum being 1.7 per cent. Just east of East Liberty Station, the Brilliant Branch runs north a distance of 3.4 miles, crossing the Allegheny River and connecting with the Conemaugh Division; also connecting with the Conemaugh Division tracks running north on the east bank of the Allegheny River. The grade on this branch is 1.4 per cent ascending southward. The 28th Street Engine House and shops are located 1.1 miles east of Pennsylvania Station, right in the heart of the city.

The Conemaugh Division runs north on both sides of the Allegheny River, on river grade; two engine houses being located on this division; one at Allegheny, on the North Side, and one at 48th Street, Pittsburgh.

The Monongahela Division runs generally south along the south bank of the Monongahela River, at river grade. Its main engine house and shops are located at 30th Street, on the South Side. South of Pennsylvania Station, a distance of three-fourths of a mile, a short grade of .85 per cent is encountered. Southbound trains stopping at Fourth Avenue Station start on this grade.

The Fort Wayne road runs through the North Side of the city along the north bank of the Ohio River. The engine house and shops are located at Columbus Avenue, North Side.

The P., C., C. & St. L. Ry. runs through the South Side of the city along the south bank of the Ohio River, and has no engine house or shops within the city limits, the power being handled at 28th Street.

There is a very close traffic relation existing between these various divisions, train movements, both passenger and freight, being laid out regardless of division lines or operating jurisdiction. To illustrate: Trains originating at Pitcairn on the Pittsburgh Division run 9.3 miles to the eastern city line, then 16.1 miles over the Pittsburgh Division, Conemaugh Division and Fort Wayne road—all in the city limits—then sixteen miles further on the Fort Wayne to Conway. Both Pittsburgh Division and Fort Wayne locomotives and crews are used on these runs; consequently, the problem of smoke regulation is a joint matter in which co-operation is necessary, not only between the interested officers of each division, but also between the officers of the various Pennsylvania System divisions centering in Pittsburgh.

The Western Pennsylvania Division, P. R. R., Lines East of Pittsburgh, has at the present time 1,040 active locomotives, any or all of which are liable to be operated within the limits of the city of Pittsburgh. Of this number, 590 are equipped with brick arches only, while 231 are equipped with brick arches and superheaters.

Locomotives in passenger service use gas coal, locomotives in freight service use run-of-mine coal, while locomotives in shifting service within the city limits use low volatile coal, except a few locomotives operating over the Duquesne Elevated, which use coke for fuel.

The problem is a complicated one, involving, as it does, the movement of heavy tonnage trains originating miles outside of the city limits, then running as high as sixteen or more miles through the city, over comparatively heavy grades, through residential sections and either through or alongside of important city parks.

Briefly, the problem is handled as follows: Each division handles all smoke regulation matters arising within its own operating territory. Frequent consultations are held by interested officers of the various divisions, in order to harmoniously handle the inter-divisional problems.

Trips by special train are made by these officers over the lines within the city limits in order to study the conditions as they exist and evolve methods to improve same. At intervals a large number of special observers are stationed at the various strategic points for several days at a time, to obtain exact data on the smoke situation, in order that intelligent information may be obtained as to the progress being made. In addition, each division has its own corps of Smoke Inspectors, whose entire time is given up to taking smoke readings and instructing crews in the proper method of firing and handling locomotives in order to reduce the smoke to a minimum.

Deck After Gas Coal Is Loaded

There are eight of these inspectors on the lines east, and, in addition, Fireman Instructors and Assistant Road Foremen of Engines spend a considerable portion of their time on this work.

The railroads co-operate in every way with the Bureau of Smoke Regulation of the City of Pittsburgh through its representatives and Chief, Mr. Henderson. Copies of daily reports of Smoke Inspectors are forwarded to the Bureau. A sample of this report, which was adopted at the suggestion of Mr. Henderson, is attached. This report, showing as it does, in detail, the observations taken, the smoke readings, character of service, location, criticisms made or instructions given, enables the Bureau to keep in close touch with the situation on the railroad, keep record of the progress made in the elimination of objectionable smoke, and gives the railroads an opportunity to know their shortcomings and correct same.

The railroad takes prompt action on all complaints of objectionable smoke received from the Bureau and the Bureau is advised as to the result of the investigation of the complaint and what action is taken in order to prevent repetition.

During the first six months of 1915 over 88,000 smoke observations were made. Six hundred and seventy-four (674) Enginemen and Firemen were criticised for unsatisfactory smoke performance. Nine thousand, seven hundred and twenty-five (9,725) Enginemen and Firemen were instructed in the operation of locomotives so as to avoid objectionable smoke. Three hundred and thirty-three (333) Enginemen and Firemen were disciplined for inexcusable unsatisfactory performance, and nine Shopmen were disciplined for the same cause. All Enginemen and Firemen have been given printed instructions covering the proper method of firing and operating locomotives in order to obtain efficient and smokeless operation. The essentials of these instructions follow:

The burning of bituminous coal in a locomotive requires air, which must be admitted through the grates and through the fire door.

Smoke means waste of coal and must be avoided.

Large quantities of coal placed in the firebox at one time cool down the fire, cause smoke and waste coal; small quantities at regular intervals will keep the fire bright, prevent smoke and take less coal to keep up steam pressure.

Lumps of coal should be broken in pieces not larger than three inches.

A bright and level fire over the whole grate must be carried whenever possible. When a sloping fire is used no more coal should be banked at the door than is necessary.

To prevent smoke and to save coal, the fire door must be placed on or against the latch after firing coal or using the scraper, slash bar or hook, and when on sidings, in yards, at terminals, or before starting.

Before the throttle is closed, the blower must be used and the door placed on latch. Fireman must stop firing long enough before steam is shut off to prevent smoke and waste of coal.

The grates must be shaken as often as necessary to clear the fire of ash and clinker in order to admit sufficient air, and in such a manner as to avoid the loss of good fire. Care should be taken to place the grates level after each operation.

Storage Yard—40 Locomotives

Coal can be saved by the proper use of the injector in pumping locomotive regularly, and by taking advantage of every opportunity to fill boiler when not working locomotive to full capacity; also by using injector to avoid the safety valves blowing off.

Coal will be saved by always working the locomotive (except when starting) with a full throttle when the cut-off is one-quarter of the stroke or greater, but if one-quarter cut-off with full throttle gives more power or speed than is needed the reverse lever should be left at one-quarter cut-off and the throttle partially closed as needed.

The railroad feels that considerable progress has been made in the effort to eliminate objectionable smoke, the best proof of this being the fact that during the first six months of 1915 there was a reduction of over seventy-eight per cent in the number of complaints of objectionable smoke received from the Bureau of Smoke Regulation as compared with the last six months of 1914.

In conclusion, it can be said that the spirit of co-operation which exists between the Bureau of Smoke Regulation of the City of Pittsburgh and the railroad officers has been responsible, in the greatest measure, for the results obtained. As a whole, it is a good example of what can be accomplished by persistence and painstaking endeavor, and, above all, by full and cordial co-operation between the civic authorities and those responsible for the operation of the great industries and railroads with which the name of Pittsburgh is so intimately connected, and all this

Deck After Low Volatile Coal Is Loaded

without the necessity of drastic action being taken to enforce compliance with the ordinance regulating the emission of black smoke.

Aside from his manuscript, Mr. Maxfield remarked at various times as follows:

The fireman has very little to do with that except possibly to put a little low volatile coal over the fire-box. Take some of our heavy east-bound express trains going East over a grade which would average 1.3%, with a maximum of 1.7%, composed probably of seven, eight or ten steel Pullman cars. They have been able to get that locomotive from the storage yard to the station and then go out from the train shed with the train beyond the city limits without firing any coal into it at all. That is simply due to the fact that with our method of banking fires, we practically prepare the fires for the Fireman before he takes hold of it. . . . I might add that does not mean violations of the ordinance by any means, but that it is unsatisfactory from our standpoint, whether it violates the ordinance or not. . . . That indicates that all of the Engineers and Firemen operating in that district were instructed a great many times to a greater or less extent in this matter. . . . That sloping fire is

Engine Storage Yard—50 Locomotives

used on some of the Eastern Divisions, such as the New York Division and down on the Coast; it is not used out on the Pittsburgh district.

After concluding his paper, Mr. Maxfield exhibited a number of interesting slides showing comparatively smokeless conditions in yards in and about Pittsburgh, where, in some cases, as many as fifty locomotives were in the yards at one time, all under steam. During the showing of the slides there was a constant firing of questions at the speaker with reference to the slides, showing that the audience fully realized what they meant and was interested in them.

DISCUSSION.

A VOICE: Can you get a picture like that every day? (Referring to the view shown where 50 locomotives under steam were shown in one yard with no emission of dense smoke.)

H. H. MAXFIELD, M. M., Pittsburgh, Pa.: Yes, sir. The condition shown on these photographs are fairly representative of the average conditions. We do not claim that we are absolutely smokeless; we do make smoke occasionally, and we have occasions when we have to discipline our men for not only violating our instructions, but also violating the city ordinance. But from the figures I quoted and my own personal knowledge, these cases are getting pretty rare. I do not think that we have had a case where we have had complaints from the city this year. I do not think we have given them any cause to complain. Of course, the City Inspector is not there all the time, and you may say that they have only been there when conditions were good; but we have our own man there all the time, and he takes about 85 observations a day, and I do not recall a single case where we had a violation. You take, of course, 50 locomotives and get them in a group with a little smoke coming out of each stack, it may be only one-quarter of No. 1, it may be even less, but all that accumulation of smoke from those locomotives is going to make more or less fog, and you can't get away from that.

J. H. LEWIS, Chicago, Ill.: I would like to ask how long it will take to get up steam where you fire a cold boiler?

H. H. MAXFIELD, M. M., Pittsburgh, Pa.: Assuming that you have 50 lbs. on, we can get it up to 100 lbs. in twenty to twenty-five minutes—not a cold boiler, but one with 50 lbs. on to start with. As to an absolutely cold boiler, I haven't got any figures.

F. M. LOGAN, Pennsylvania Lines East, Pittsburgh, Pa.: On a cold boiler it will average forty-five to fifty minutes to raise it up to 100 lbs.

H. H. MAXFIELD, M. M., Pittsburgh, Pa.: On our K2 locomotive, 72x110—heaviest passenger engines.

J. H. Lewis, Chicago, Ill.: The reason I ask that question is this: The way we are situated, we practically have orders to send our engines out almost the minute we are in the house; yet at the same time we have to wash out a great many engines that come 163 miles from other divisions. Now the Dispatcher says, "I want that engine at such and such a time." We tell him that it is not in the house. He says, "Well, get it ready as soon as you can."

I have taken one of our large freight engines and put it in the house, run the water out of it and given it a quick washout because I wanted to get the engine out on the road.

Now, that fire-box runs from 80 to 120, some of them, and some 132, and to get up steam in that engine in forty-five minutes I have to use oil and all kinds of kindling and the round-house draft, and put about 40 and 50 lbs. on, and even then it takes me forty-five to fifty minutes to get enough steam to put that engine out on the turntable, and the water leg and fire-box are cold six inches above the ring. Now, if it can be done in any other way, I would like to know it. If you gentlemen can fire up an engine as easy as you say you can, I will be very glad to learn how to do it. I am free to acknowledge that I do not know practically any railroad man in the city of Chicago that is more anxious to learn than I am and has as many difficulties to tackle, perhaps, as I have. Of course, they all have their troubles.

Now, if I heard you aright, I understood you to say that after your engine left the roundhouse under a banker fire, the engine went down into the depot—if I am wrong please correct me—and pulled a train consisting of nine or ten steel cars six miles without putting any coal in. We have tried that, but I am free to tell you that we cannot do it. Now I tell you when you take an engine out of the roundhouse—

H. H. Maxfield, M. M., Pittsburgh, Pa.: Understand me, it is not an every-day occurrence, but we have done it. This is an exception.

J. H. Lewis, Chicago, Ill.: We are not getting down to any special attempts. What we want is every-day smoke prevention.

H. H. Maxfield, M. M., Pittsburgh, Pa.: I do not doubt that.

J. H. Lewis, Chicago, Ill.: But when you come to firing up an engine and talk about getting it out of the station, and running six miles without putting fire in, pulling nine or ten steel cars up a grade, that man that is firing that engine has got to work like thunder and has got to make steam to keep her on the road. It does not seem to me that it can be done.

H. H. Maxfield, M. M., Pittsburgh, Pa.: I did not quote that as an every-day proposition. I merely made that statement to illustrate the character of the fires as they turned the locomotive over to the fireman. Now, as a matter of fact, it has been done, but it is not an every-day occurrence. It may happen only once a week, but the fact is that it has been done. I merely quote that to illustrate the fact that we were giving those firemen mighty good fires, and they will admit that themselves. It requires very little work on their part. I am referring now to the fact of getting that locomotive outside of the city without violating the ordinance. When you come to make the Pitcairn-Connolly run, you have an entirely different proposition, as I stated, and it makes probably eight times as much smoke on that as at any other point in the city.

M. D. **Franey**, M. M., L. S. & M. S. Railway, Elkhart, Ind.: I want to compliment Mr. Maxfield on his very capable paper, and I want to congratulate the Association on being able to listen to such a paper and to see the lantern slides.

I regret very much that my friend Lewis and myself from the same territory must disagree a little on possibilities. I am quite sure that the conditions that Mr. Maxfield has pictured here today are possible conditions, and I am quite sure that they are conditions that will exist in a well regulated terminal, I will say, fully 70 per cent of the time; and I am quite sure when I say 70 per cent that investigation would show a higher percentage on good conditions than 70 per cent.

We are located at Englewood Station in Chicago, and have a different condition from that pictured by Mr. Maxfield, although the final results are probably the same. We are on level track, practically sea level, on Lake Michigan. Our locomotives, however, are worked to their full capacity. You will readily understand that when I say our fast freights will have from 80 to 85 cars and from 2,800 to 3,000 tons, and they will make a 133-mile division in practically five hours' time, or less. In order to get them out of the station it is necessary that the man shall work the engine to its maximum capacity. When you are working an engine to its maximum capacity on level track, you have practically the same conditions that you have if you are working the engine to the maximum on a hill, for your engineer and fireman are building up a good, heavy fire, knowing that the locomotive is going to be worked to its maximum capacity, and if the steam is suddenly shut off, they are confronted with an emergency condition and one or two things has got to happen, either you must have an excellent smoke consuming appliance on your locomotive, or you must violate the smoke ordinance.

We feel that we have our locomotives so equipped that smoke violations, even under the conditions that I have mentioned here are inexcusable on the part of the fireman. Our locomotives are all equipped with superheaters; by that I mean that all of our Pennsylvania passenger engines and our freight engines, and also our McAdoo type of freight engine, are all equipped with arch tubes, with a brick arch carried on the arch tubes. The large locomotive has 1¼-inch blower on the right, and a 1¼-inch blower on the left side. The left blower is connected with the well-known form of steam jet smoke consumer which induces cold air. It is familiar to all the members.

Now as to the fire-box, the steam jet and the air induction is admitted between the live coals under the brick oven through the sides of the fire-box. The air jets or air induction is admitted through the sides of the fire-box above the bed of coals and under the brick arch. If the fireman will put on the left blower steam jet, or smoke consumer, and brake the door slightly—he does not need to open it fully—brake it slightly—he can prevent smoke, and we would then have the additional 1¼-inch blower on the engineer's side for an emergency.

When I say that we prevent smoke, you will readily understand that I mean that it will come within the requirements of the city ordinance.

In the Terminals we have Dispatchers that tell us that they want the engine and they want it in a hurry, and sometimes their trains are waiting, but the trains wait right there until our locomotive is fixed. We repair it, we wash it. The man that puts in the plugs and does not wash that locomotive thoroughly, regardless of how badly they want it, there is something doing if we find it out. I suppose they do put one over us once in a while, but when we catch them we try to prevent it happening the next time. If a locomotive needs a washing, it needs a thorough washing.

We have to fire up our locomotives and get them out in less than an hour, and we use a hot-water filling system. I think it is possible, but I would not want to say that we would fire a locomotive in forty minutes and come within the smoke ordinance as thoroughly as if we were to take a little longer time. We use wood from the repair yard, which we term "listings," for firing our locomotives in Chicago territory. That is ignited with waste which is saturated with oil—old waste saturated with oil, a small piece of waste.

Terminal conditions I will treat of later, but I want to show that in connection with firing up locomotives we have obtained splendid results by putting a Tee in the left blower line of the locomotive, locating this Tee just about even with the forward end of the fire-box. When firing that locomotive we would turn on steam and open the smoke consumer, using the smoke consumer in connection with the blower while firing up the cold locomotive. This reduces the dense smoke in our opinion 30 to 40 per cent. I do not know whether the other members have tried that or not, but we have obtained splendid results in doing this.

On our switching locomotives in terminals we are using what we term a full arch. We leave the two corner bricks in the forward end of the fire-box out entirely—I think it is three, I am just speaking from memory now—I think it is three that we leave out at the back end; otherwise it is a solid brick arch throughout the locomotive carried on the arch tubes.

F. M. LOGAN, Pennsylvania Lines East, Pittsburgh, Pa.: Mr. Lewis from Chicago there said that he did not think it was possible to get that with a locomotive. Now gentlemen, I will tell you something—

J. H. LEWIS, Chicago, Ill.: I didn't say that; I said that I was here to learn how to do it.

F. M. LOGAN, Pennsylvania Lines East, Pittsburgh, Pa.: I beg your pardon. I will tell you something that was done for twenty days: We had a man there who hauled four steel cars 14 miles from Pitcairn to Pittsburgh, and never put a shovelful of coal on the fire from the time he left Pitcairn until he came to Pittsburgh, and he made nine stops.

MR. TRUSSEL: I see that this paper is entitled, "Smokeless Locomotive Operation Without Special Apparatus." Do I understand from that that you have neither a brick arch nor a smoke consumer?

H. H. MAXFIELD, M. M., Pittsburgh, Pa.: You understand nothing of the sort. I told you in the paper that we used a brick arch and that we used superheaters. I suppose we have a certain amount of special apparatus, which I showed on the screen. The brick arch and superheaters were put in apparently for economy and not to reduce smoke.

MR. TRUSSEL: In regard to your method of banking fires; we have found that the most successful method is to bank the fire on the back side, and bank as heavy as we can consistently, for if we bank our fires heavy enough to go any great distance, with the coal we use we will run out of steam. We bank the fire on the back side, but we have good firing. The fireman has to get real busy as soon as he gets away from the station, where he thinks he is justified in putting in green fire. We get out very satisfactorily by using smoke-burning steam jets and firing the locomotive on one side, and having a good heavy fire to start with; but if we do not have the heavily prepared fire, we cannot get it under any condition without making a dense smoke.

In regard to the roundhouse proposition, I have no experience, because our roundhouse is inside of the smoke zone; but we are not able to bank our fires sufficiently heavy to go probably over a train length of 10 or 12 steel cars without the fireman having to get busy. We have brick arches and three or four smoke-burning steam jets on each side. We work them in connection with the exhaust 1¼-inch blower to be used when we shut off. On the fire doors I have a hook about 2 inches or 2½ inches wide that will let the door slide back, and the fireman uses that on the terminal to make about a 2-inch opening of the door. We think that is of considerable benefit. It makes it possible for the fireman to use his automatic door rather than work it by hand going out of his terminal, and still have a sufficient opening to take care of the smoke.

H. H. MAXFIELD, M. M., Pittsburgh, Pa.: Of course you understand that this operation that I have illustrated this morning is a first-class passenger train.

Speaking of the cold boiler proposition, Mr. Lewis, it was not cold water that we put in the boiler. We fill our boilers with hot water. I do not want you to misunderstand that. When I spoke of firing up a cold boiler, I was referring to a boiler which has no steam on at all, but is filled with hot water. Of course that simplifies the proposition.

J. H. LEWIS, Chicago, Ill.: You understand that I want to give you credit for the good work that Pittsburgh does, and I have no doubt but what you are absolutely correct in your statements; but at the same time this roundhouse work is all bright one day, and all blue the next day. I have had twenty-seven years' experience with roundhouse work, and as my friend Mr. Franey said there about washing out boilers, a great deal depends upon the Superintendent of a Division in which you are working as to whether you will wash out boilers good, or bad.

PRESIDENT TOWNER: It may be that in the papers that are to follow we will have a lot of argument coming up on roundhouses, etc., so that we may be taking up useless time now, because I see that the next paper is on "Various Methods of Eliminating Smoke From Roundhouses," and then there are other papers that cover smokeless operation of locomotives, so that possibly we are losing valuable time in not proceeding at once to those papers, as we must be out of this room by 12:00 o'clock. We have three more valuable papers. If it is the sense of the meeting that we proceed with the next paper, I think this same subject will be covered by it, so that with your permission we will proceed with it.

The next paper is by Mr. M. D. Franey, M. M., L. S. & M. S. Railway, Elkhart, Indiana, on "Various Methods of Eliminating Smoke From Roundhouses."

M. D. FRANEY, M. M., Elkhart, Ind.: In presenting this paper before you today, I find myself in rather a peculiar position. I am about to describe to you a device for the complete washing of smoke from locomotives, a device which, as far as I know, is the only one of its kind in existence. You have heard the paper that preceded the one which I am about to read; you have seen the photographs of the Terminals at Pittsburgh; and I want to say from my experience, as stated on the floor this morning, that I believe those pictures represented a possible condition; and you have noted from the photographs that the conditions as therein pictured are well within the requirements of the most rigid smoke inspection.

The device that I am about to describe, however, goes a little further. I regret that I have no lantern slides and that I am not prepared to illustrate on the canvas the conditions that exist at the plant where this smoke-washer is installed; but I have a few pictures and a few prints of the device that I anticipate will be reproduced in the Proceedings of the meeting, and I am merely bringing them with me that they may be made matter of record.

The speaker then proceeded with his manuscript, as follows:

WASHING SMOKE FROM LOCOMOTIVES OF THE NEW YORK CENTRAL RAILROAD COMPANY AT THE ENGLEWOOD ENGINE HOUSE, CHICAGO, ILL.

M. D. FRANEY, M. M., Elkhart, Ind.

The citizens of Chicago have been exceedingly energetic in enforcing the ordinance regulating the emission of smoke, especially with reference to locomotives. As a result of this campaign, the Smoke Department of Chicago is very observant and insistent that the railway companies comply with the ordinance. This not only applies to locomotives in active service, but it also applies to the locomotives around the terminals, locomotives standing at the engine house, and those that are having new fires started in the engine house.

The New York Central engine house is located at Englewood Station, Chicago, near Indiana avenue and Sixty-third street. It is adjacent to the White City, a popular amusement park, and surrounded by a very desirable residence district. The citizens take civic pride in maintaining shrubs and flowers, making the surroundings very homelike. They are very insistent on the abatement of smoke and the reduction of unnecessary noise, such as the ringing of bells, blowing of whistles, escape of steam through the safety valves, and the excessive use of the blower which is sometimes necessary in the abatement of smoke.

To fully comply with the smoke ordinance, the officials of the New York Central, like those of other railroads, have made very exhaustive tests and a careful study of the various appliances for smoke prevention, the Mechanical Department finally adopting the well-known form of steam jet smoke consumer, which induces the air above the fire and under the brick arch at the same time, drawing the gases out of the fire-box by means of a large capacity blower in the front end of the locomotive. The locomotives west of Buffalo are equipped with two 1¼-inch blowers, one on the right and one on the left side. The left blower is connected with the steam jet smoke consumer. With the use of ordinary care and the steam and blower appliances of the boiler in proper working order, there is no excuse for smoke violation after steam has been generated.

The smoke consumer is of very little assistance in building a new fire in a cold locomotive, and this was the great problem which confronted the Mechanical Officers of the New York Central in 1910, at a time when it was found absolutely necessary to build a new engine house and terminal facilities at the Englewood Station. Due to the protests of the residents, the city officials objected strenuously to a new engine house being built at that point, because of the possibility of smoke and noise attending such a plant.

At this time Mr. O. M. Foster, Master Mechanic in this territory, after a careful study of smoke-washing devices which had been tried at other places with partial success, conceived the idea of forcing the smoke by means of a fan through a large body of water, separating the unconsumed carbons from the gases, permitting the latter to escape through a high stack and holding the carbons and other solids in suspension in the water. Mr. D. R. MacBain, Superintendent of Motive Power, had made a lifelong study of smoke abatement devices, and approved of the plan. A small plant was built at Elkhart, capable of taking care of one locomotive, and which gave results beyond their expectations.

Before this single-unit plan was perfected, Mr. MacBain assured his superiors that he would have designed a successful smoke-washing device for the Englewood engine house. This assurance was given to the city officials of Chicago, with the promise that the engine house would be built without a smoke jack leading direct to the atmosphere, and that it would be maintained without smoke and noise, even from locomotives which were having new fires built in them.

To more thoroughly test the device, an experimental plant was built at Collinwood to take care of several locomotives. This was constructed from the data worked out in the operation of the Elkhart plant, but it was found necessary to make various changes on account of handling a larger volume of smoke, installing baffles, steam jets and other means of compelling the smoke and gases to travel along definite lines. With the data collected from this experimental plant, the present smoke-washer at Englewood was designed and constructed. It was very evident that the washing of smoke under the new plan was entirely practicable. The only drawback was in securing material that would withstand the powerful action of the various acids resulting from the combination of the gases, the solids and water.

The Englewood engine house contains 30 stalls, in which from 80 to 100 locomotives are handled per day of 24 hours. This engine house, as stated before, is built without a smoke jack leading direct to the atmosphere.

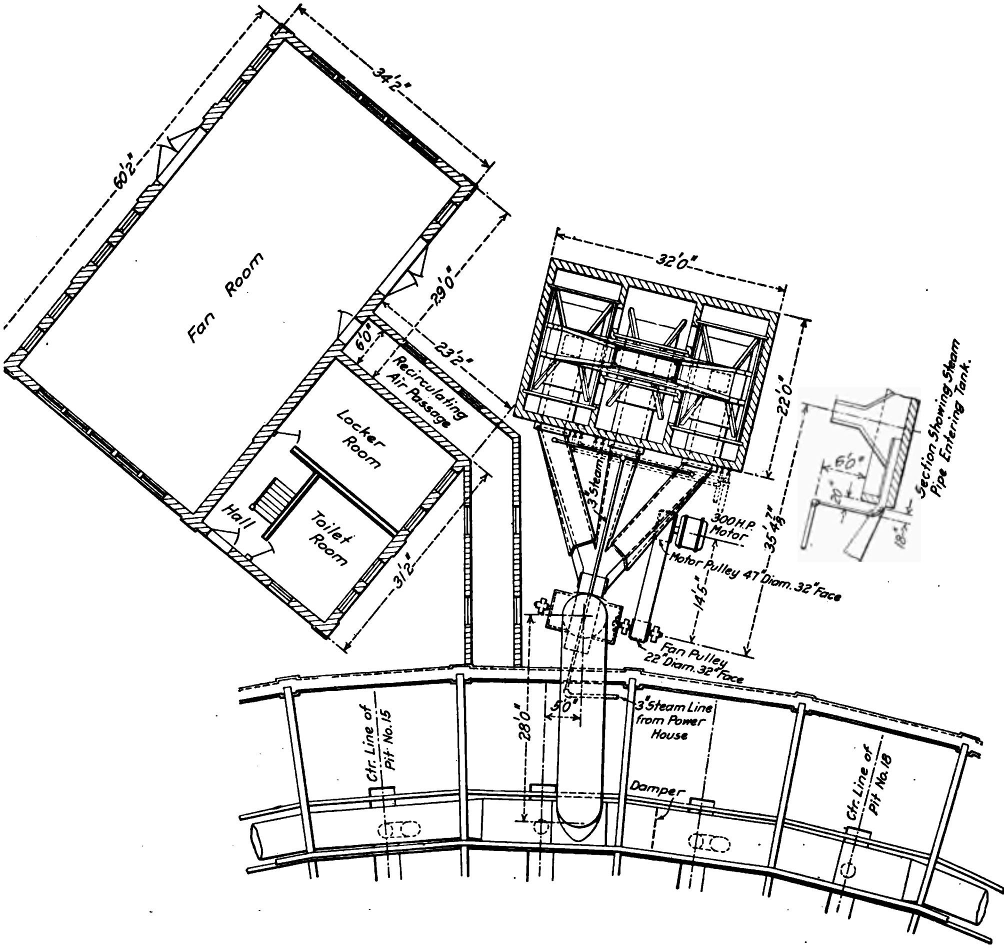


Fig. 1. Plan of Locomotive Smoke-Washing Plant at the Englewood (Chicago) Engine House of the New York Central

In washing the smoke, a large concrete tank is used, 22 ft. x 32 ft. This tank is subdivided by separating walls into three basins. Each basin is lined on the interior with dressed lumber set in about 1½ inches from the concrete. The space between the concrete and the lining is filled with tar. Wooden pins, instead of nails, are used for fastening the lining, this to resist the action of the acids. Fig. 1 shows the plan of the tank, the stack, the three hoods, the three ducts connecting the fan with the concrete basin, the fan and motor and the elbow connecting the fan with the large smoke duct in the engine house to which the smoke jacks connect. An elevation of this arrangement is shown in Fig. 2.

A large smoke duct, 60 inches in diameter at the center and tapering off to 36 inches at the ends, extends around the house just under the roof

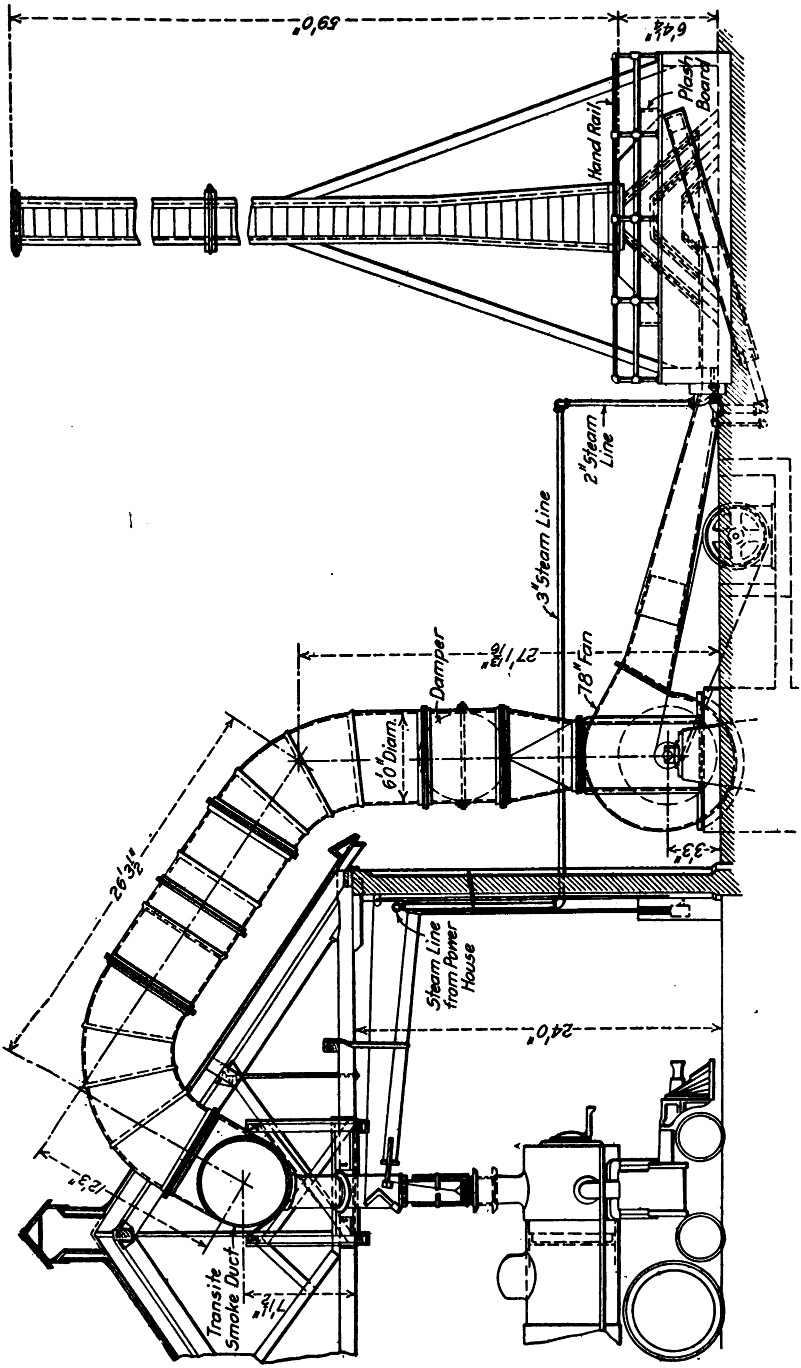


Fig. 2. Locomotive Smoke-Washing Plant at the Englewood Engine House

and directly above the smoke stacks of the locomotives when the latter are headed in and standing in their normal position. This smoke duct was built of transite material, and connected with a drop pipe leading down to each pit. In each of these drop pipes a damper was built, with a mechanism for opening and closing. Leading down from each drop pipe is a telescopic jack made from cast iron and supported from the roof. The lower end of the jack is provided with a conical hood to fit over the stack of the locomotive. These telescopic jacks have vertical, lateral and longitudinal movement to accommodate different positions of the locomotive stack. The jacks are raised and lowered by a walking beam counterbalanced with a weight and operated from the wall of the engine house, as shown in Fig. 2. The damper is opened and closed from this same point.

Near the center of the house a large elbow connects into the top of the 60-inch transite duct and leads down to a 78-inch steel plate, double-inlet fan, capable of handling 68,000 cu. ft. of 500° gases per minute, at a total static pressure of 14 inches at fan outlet, and at a speed of 950 R. P. M. The fan is belt-driven by a 300 H. P. constant speed, 300-400 R. P. M. motor. A smoke duct leads from the fan to each of the three concrete basins, the outlet to each duct coming directly under the hoods referred to above and shown in Fig. 2. There are three hoods in each tank. The top of the interior hood is open, while the top of the second hood is closed similar to a bell; the top of the third or outer hood is open and connects with the stack, which is approximately 60 ft. in height. The three smoke ducts leading from the fan, the hoods and the stack are made of wood pinned together with pegs instead of nails. The lower portion of the three hoods extend down in the concrete basin and are submerged in the water.

An 8-inch hole is provided in each of the separating walls to insure a uniform level of water in the three basins. A special overflow pipe is provided to maintain 14 inches of water in the tanks and to prevent the carbons from escaping into the sewer. A 1¼-inch high-pressure steam jet, with proper elbow and nozzle pointing towards the outlet, is located in each of the three ducts and close to the concrete tank, as shown in Fig. 1. The purpose of these steam jets is to accelerate and thoroughly mix the gases with the water and prevent them passing through the water in large bubbles.

In operation, the telescopic jacks which are not connected with a locomotive having a fire in it, have the dampers in closed position. Locomotives with a fire have the jacks closed on top of the locomotive stack and the dampers opened.

In starting new fires, it is necessary to use the house blower slightly, this to assist the action of the fan, especially at extreme ends of the house. The gases are drawn through the jacks, transite duct and the large elbow, into the fan. They are forced from the fan through the three smoke ducts, through the water, passing out into the first hood. At this point the gases are accelerated by the steam jets referred to in a previous paragraph. The gases are engulfed by the spray and wave action of the water, passing out through the top of the first into the second hood or bell, which latter it will be remembered has a closed top. They are forced down below the lower edge of this bell, passing between the second and the third hood, and out into the stack.

The carbons and solids are separated from the gases by repeated washings, and rise to the top of the water in the tank in the form of a black, foamy scum. The gases pass out through the stack as a white vapor. In handling 80 locomotives per 24 hours, from 8 to 10 barrels of carbon are obtained from the smoke-washer. This has the appearance of lampblack, and is thoroughly steam-dried after it is taken from the smoke-washer. An analysis of this material is shown in the following composition:

Moisture	3.9%
Carbon	82.6%
Sulphur	2.6%
Iron oxide	8.7%
Silica	1.8%
Calcium oxide	Trace

The sulphur and sulphuric acids are retained in the water, and the gases that pass out through the stack are practically odorless. The Smoke Department of the city of Chicago and the nearby residents are very well pleased with the results obtained and have complimented the plant very highly on numerous occasions.

It is estimated the cost of making an installation, as described, would be from $15,000 to $18,000, where the property conditions are favorable. Owing to the property conditions and to the fact that this plant is an experimental installation, the actual cost was somewhat greater.

We made an investigation sometime ago as to the cost of operation, and give below the results in brief:

COST OF OPERATION PER DAY OF 24 HOURS.

Water, 18,255 gallons @ 7c per M	$ 1.28
Coal, 10.86 tons @ $1.75 per ton	19.00
Electricity, 3,360 kilowatt hours @ $0.0129	43.34
Total	$63.62

SAVING EFFECT BY THE USE OF WASHER PER DAY OF 24 HOURS.

Fires maintained	$40.80
New fires built	7.11
Reduced electrical cost due to sliding scale rate	8.52
Total	$56.43

This makes the net cost of operating the washer $7.19 per day of 24 hours ($63.62 less $56.43). It is expected that we will be able to find a profitable use for the lampblack reclaimed by the smoke-washer. This would, of course, result in still further decreasing the net cost of operation and possibly show a profit in the operation of the smoke-washer.

In a closely regulated smoke abatement territory it is necessary to maintain the blower for a period after a green fire is put in, and to use the smoke consumer. The action of the blower and the smoke consumer increases the draft on the fire, which increases the coal consumption, and the blower, steam jet and smoke consumer are also using a large amount of steam, which in turn means increased consumption of water and increased consumption of coal to produce the steam. We have found at our Englewood plant that where the fires are properly started, the draft from the fan is sufficient to draw off the gases from the locomotive without the use of the blower. This means a decided reduction in the amount of water used, due to not using the steam blower, and also means a decided saving in coal consumption, due to the reduced draft.

While we have quoted the results of some tests made, it is difficult to obtain a set figure as to the amount of coal and water consumed by an engine at a terminal, due to varying conditions, such as smoke restrictions, temperature of the weather, and the human element or fire-up man. We found in our tests that the coal consumption in all engines is subject to a wide variation. On engines stored in the circle and tracks outside of the house, this is from 25 to 75 per cent greater than on engines in the house. This is influenced by the skill of the fire-up man and the number of engines he has to handle. At times, in his anxiety to comply with the smoke ordinance, blowers and smoke consumers would be in constant use. The tests showed to our entire satisfaction that the coal and water consumption is very materially reduced on engines stored under the smoke jack and influenced by the draft of the smoke-washer fan. The temperature of the fire-box is more even and the fire-up man is able to handle a larger number of locomotives.

Past experience has demonstrated that the acids will eat out concrete and metals very rapidly. Transite for the smoke ducts throughout the house appears to be very satisfactory. A wood lining, fastened with wooden pegs, the entire surface coated with tar, appears to be very satis-

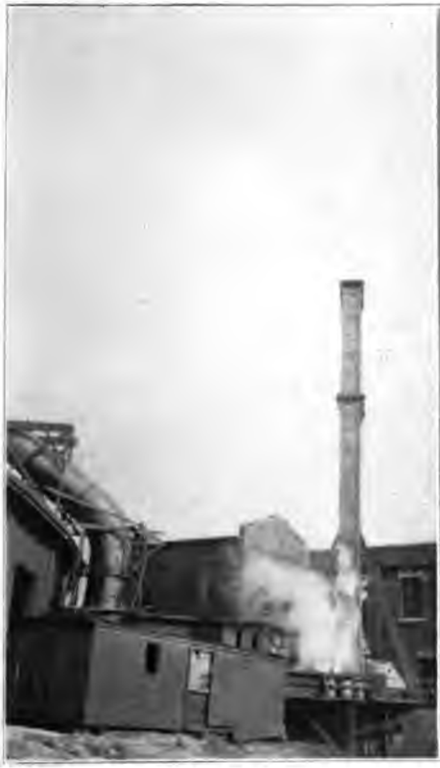


Fig. 3.

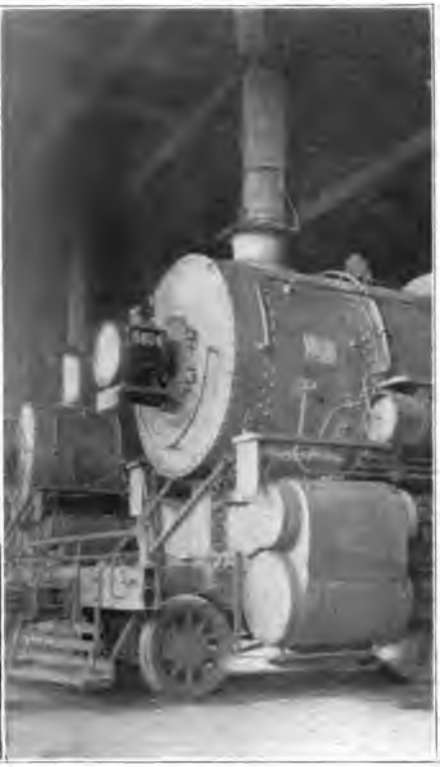


Fig. 5.

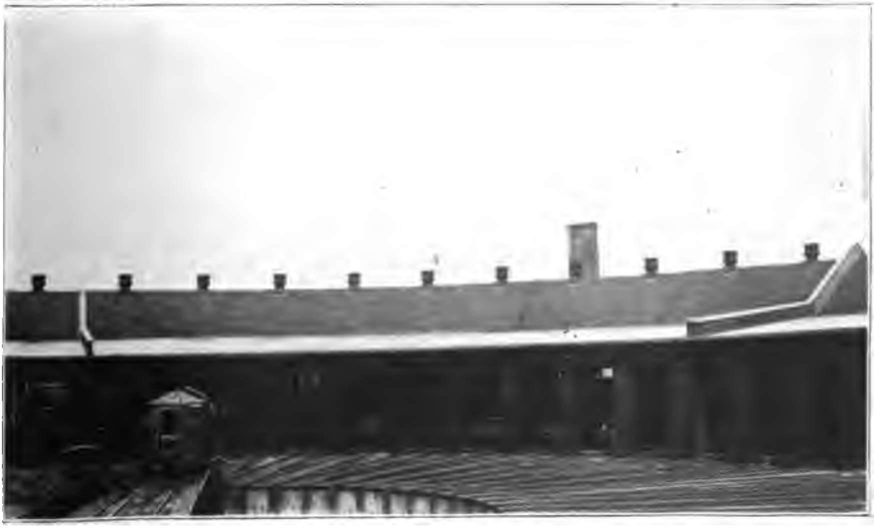


Fig. 4.

factory for the portions of the apparatus that come in contact with the water and acids. Past experience has demonstrated that concrete and metal are not satisfactory for this purpose. Future construction for these parts will probably be of treated wood.

Fig. 3 shows the drying shed in the foreground; to the right is shown the tank and stack, with the vapors escaping from the top. The 60-inch elbow connecting the fan to the transite duct is shown to the left. Fig. 4 is a view from the inner circle, showing the stack as it rises above the roof of the engine house. Fig. 5 shows the interior of the house, with the telescopic jacks pulled down on the stack of the locomotive.

PATENTS.

This smoke-washer is operated under patent controlled by the American Smoke Washing Company, incorporated in the State of Illinois, of which Mr. S. K. Dickerson, 5120 Greenwood avenue, Chicago, Ill., is Secretary.

Aside from his manuscript the speaker remarked at one point, as follows:

The large tank, as will be apparent to the members when they read the description in the Proceedings and can refer to the detail drawing, consists of three large concrete basins, with a smoke duct leading to each one of these tanks, so that the smoke is simply forced through these three ducts by means of a fan and passes through certain baffles, which will be described later. After passing through repeated sprays and wave-action of water, it is continually washed and the gases pass out through the stack.

PRESIDENT TOWNER: Mr. F. Bauer, M. M., Big Four Railway, Indianapolis, Ind., is also assigned a paper on a similar subject. Mr. Bauer requests that on account of the condition of his voice this paper be read by Mr. J. D. Skeen of the C., C., C. & St. L. Railway, Cincinnati, Ohio.

Mr. Skeen read the paper as requested, as follows:

METHODS OF HANDLING LOCOMOTIVES AT TERMINALS WITH VIEW OF ABATING SMOKE IN MOST EFFECTIVE AND ECONOMICAL MANNER

F. BAUER, C., C., C. & St. L. Ry. Co.

The problem of abating smoke from locomotives in and around locomotive terminals in large cities is one of the most difficult and annoying problems which the motive power officials have to contend with today.

In the majority of cases the engine house terminals in our large cities are located in the heart of the city, or in the residence districts, where it is absolutely essential that smoke be practically, if not entirely eliminated.

It would not be far from the truth to say that the vigorous campaigns that are being waged in many cities towards electrification of the railways are brought about more from the smoke nuisance in and around engine house terminals than anything else. In many cases railways, in order to avoid continuous criticism, have gone to a great deal of expense by moving their engine house terminals outside of the city limits. This, of course, means the expenditure of great sums of money, as well as a continuous expense on account of light mileage for engines, as well as other inconveniences, such as inability to get competent labor, transportation and housing for men, delay to power, etc.

To avoid criticism by moving away from the city limits is therefore not at all times the correct thing to do, as it usually will not be very long until the city limits will reach out to the new location, when the problem will have to be faced again.

Experience has shown that smoke from locomotives around engine house terminals can be practically eliminated, so the proper thing to do is to face the problems as they exist and not run away from them.

The emission of smoke from locomotives when in and around a terminal can be properly divided into three stages:

First. The time when the engines are fired up and gotten hot in the house.

Second. The time when the engines are hot and parked outside of the house waiting departure, and under the care of hostlers, engine watchmen or firemen.

Third. The time when the engines arrive at the terminal after a trip.

The first or firing-up stage is the most difficult one to contend with. The second and third stages are comparatively easy, and can be coped with by rigid discipline and vigilance on the part of the engine house foreman and the road foreman of engines.

In order that smoke may be properly abated during any one of these stages it is absolutely essential that each and every engine be properly equipped with smoke-consuming devices, namely, first, a properly constructed and maintained fire brick arch in the fire-box.

The importance of this device as a smoke preventer has been so thoroughly proved that it needs no further comment. The principal function of the arch being to store up heat and thereby maintain a high and uniform temperature in the fire-box.

Second. Smoke consumers or combustion tubes in the sides or back head of the fire-box to admit sufficient quantities of air to combine with the volatile combustibles.

There are a number of different designs of smoke consumers used. The simplest one consists of combustion tubes in the side of the fire-box, from four to six on each side, depending upon the size of the fire-box. Each combustion tube should be not less than two inches in diameter, and equipped with a steam jet nozzle, the nozzle being so placed with relation to the combustion tube so as to inject the greatest quantity of air with the least amount of steam.

This device has been tried out on the road with which the writer is connected and has been found entirely practical and satisfactory, and nearly all engines, or about 900, are so equipped.

Third. Two blowers in the front end, each blower connected with not less than 1¼-inch pipe to the fountain, and a connecting pipe between the blower connection and the smoke-consuming device, in such a manner that the steam will be admitted to the steam jets of the smoke consumer from the engine house blower lines. The importance of the large capacity blower on the locomotives must not be underestimated.

From several years of experience with engines of all classes equipped as above mentioned, it has been found that with reasonable care on the part of the firemen, smoke can be abated on the locomotive at all times, and that there is absolutely no excuse for the emission of smoke from an engine so equipped.

With such engines the Road Foreman of Engines can show and prove to the firemen at any time that the smoke can be eliminated practically instantly, and that there is no excuse for making black smoke. If an engine smokes it is caused by utter carelessness, indifference and disregard of instructions on the part of the fireman, and will enable the Road Foreman of Engines to administer discipline if necessary.

With engines that are not properly equipped as above mentioned, it will require the greatest care and skill on the part of the fireman to fire the engine smokelessly, and which under varying operating conditions is not entirely possible and will make it difficult for the Road Foreman of Engines to prosecute the smoke abatement work satisfactorily and effectively.

As previously mentioned, the firing-up stage is the time when it is most difficult to burn coal in the locomotive fire-box without making smoke; the reason for this is too well known to require further explanation.

To eliminate smoke during this period a number of different methods of firing up engines are in use, and many different smoke consuming or smoke collecting apparatuses have been tried out. The last mentioned devices are still in the experimental stage, and will only be mentioned in a casual manner later.

The most common method of firing up engines is by means of wood, corn cobs or shavings, saturated with crude oil and applied on a bed of coal on the grates. The usual practice has been to cover the grate with from 6 inches to 8 inches of coal, and then throw in a quantity of oil soaked shavings or wood over the entire surface of the grate area. When the wood or shavings are ignited the fire immediately spreads over the whole grate surface, igniting the entire quantity of coal placed in the fire box. This quickly liberates a great deal of the volatile combustibles in the coal and in such volumes that it is impossible for it to be consumed, due to the low temperature in the box; great quantities of unconsumed volatiles and smoke will be emitted, to a certain extent choking the fire already started and delaying the process of ignition.

About a year ago we started on the central district of the Big Four to experiment with different methods of starting the fires.

It was recognized that in order to reduce the smoke it would be necessary to ignite the coal bed gradually, so as to enable the flames to consume the volatiles as they were liberated.

During the various experiments the grate area was covered with a thin layer of coal, from 4 inches to 6 inches thick. Some experiments were made by placing the oil saturated shavings in the front end of the fire box only. Some experiments were made by placing the shavings on one or both sides of the fire box only, and some were made by placing the shavings in the back corners of the fire box.

Careful observations were made as to the results obtained and it was found that by placing the shavings in the back corner of the fire box, the best results were obtained.

With this method approximately one cubic foot of oil saturated shavings were placed in each back corner of the fire box. These shavings were then ignited and it was found that the fire first ignited the coals immediately under the shavings and then gradually spread forward towards the front of the fire box. As the fire spread forward the volatiles liberated were passed back over the flames from the shavings and the ignited coals and so were consumed.

A number of tests were made in this manner and it was proved conclusively that, with the aids of the strong house blower and the smoke consumer, the engines by these means, could be fired up entirely smokelessly.

This system of firing up engines has been adopted at all round houses on the Central District of the Big Four and very satisfactory results have been obtained. All complaints from smoke have been entirely eliminated, while previously continuous complaints and criticisms were received.

With reference to the results obtained by placing the shavings on the sides or in the front corners of the fire box, it was found that owing to the difficulty of placing the shavings exclusively at these points, without spreading same over the entire grate area, the result sought for could not be accomplished.

The above satisfactory results, however, could only have been obtained through the help of the equipment of the locomotives, as well as an abundant supply of steam from the stationary plants, and a properly and adequately installed blower line.

As it requires approximately 20 pounds of steam per minute, or 40 boiler horsepower per hour, at 100 pounds pressure to supply a ½-inch blower connection, it is apparent that ample boiler capacity for supplying the blower lines should be provided if results are to be obtained.

For an engine-house where ten engines are liable to be fired up at one time it is apparent that 400 boiler horsepower should be provided for the house blower only, and it must be borne in mind that a great many blowers are being used by the boiler makers when working in the fire box.

Additional and adequate stationary boilers for this purpose have been installed in practically all round houses on the Big Four. They have proved to be a source of great benefit, as well as economy, as not only can adequate steam be generated in stationary plants at greater efficiency than from the locomotive, but the time required to get the engines hot has been materially reduced, resulting in a saving of coal as well as time.

Another very important feature is the adequate and properly installed blower line. In a round house of twenty-five stalls, not less than a 3-inch main blower line should be used, and for larger engine houses a proportionally bigger blower line should be provided. The blower line should be supported from the roof of the house by means of flexible hangers so as to provide for the expansion of the pipe. The line should also be placed on an incline so as to drain, and large traps provided to remove the condensation. The drops between each stall should be made of at least 1-inch wrot iron pipe with metallic flexible joints. The drops should be taken from the top of the blower line so as to avoid condensation; the controlling valve should be placed overhead, near the main blower line, the valve operated by means of an extension rod to the blower. Great importance should be attached to getting a large, first-class extra-heavy valve for this purpose, not less than 1½ inches in diameter, with proper reducing fittings, as these valves are subjected to severe service. The blower line should also be properly covered so as to reduce condensation, and protect the pipe against corrosion.

Other important features in connection with this, of course, are that the house is large enough so as to permit placing the engines directly under the smoke jacks, thus enabling the doors to be closed, and also that the smoke jacks are of ample dimensions to carry away the gases.

The last, but not least important requirement, is the strict discipline and continuous vigilance on the part of the engine house foreman to properly correct any inefficiency or carelessness on the part of the fire-up men.

Another method for firing up engines that has been used at terminals under the writer's jurisdiction, and is being used at other points, is to use coke or wood, and afterwards building the fire up with coal. This method proved not only expensive, cumbersome, and inefficient, both as regards labor and material, and the time required to get the engine hot, but also proved unsatisfactory from a smoke eliminating standpoint, as trouble was experienced with smoke when building the fire up with coal before the engine was ready to leave the terminal.

Another method which is used at a number of places consists of applying coal to the fire box and igniting it by means of a crude oil burner. This method has been observed by the writer on numerous occasions, but have noted unsatisfactory results as far as smoke abatement is concerned.

Of all the above mentioned methods, the method and organization as described in detail and which has been in force at terminals under the writer's jurisdiction on the Big Four for more than a year, has given most gratifying results as to smoke elimination.

In the beginning of this paper mention was made of various apparatuses installed for collecting and consuming smoke made while firing up engines. As stated before these are more or less in the experimental stage and will, therefore, only be dwelt upon in a casual manner.

One from which the most practical results have been obtained is the one installed at the Englewood round house of the N. Y. C. lines at Chicago. This apparatus consists of a duct made of asbestos boards placed directly under the roof in the round house. To this duct is connected telescoping smoke jacks also made of asbestos board, and so designed that it can be lowered or raised by means of counter balance, and practically air tight joints made to the smoke stack on the engines.

This smoke duct is carried to two large exhaust fans driven by electric motors. These fans are of very large capacity so as to produce the necessary draft for firing up the engines without the use of the steam blower. The smoke is drawn by means of these fans through the duct and discharged into a large vat filled with water. Into this water vat live steam is emitted in sufficient quantities to raise the water to a practically boiling point. The smoke when forced through this vat of water is washed completely. This installation, of course, is a very expensive one, not only to install, but also to operate.

Another method for collecting the smoke that has been tried out, and has come to the writer's attention, is the one installed at the C. & A. terminal in Chicago. This consists of a galvanized iron duct with telescoping smoke jacks, the duct connected with a fan, discharging the smoke through a high stack. This device was in operation only a very short time as the galvanized iron duct, fans, and stack were quickly eaten up by the sulphur gases from the smoke.

Another system similar to the last mentioned, we understand, has been installed by the Pennsylvania R. R. in the Allegheny round house near Pittsburgh, Pa., the only difference being that in the capacity of the plant and the use of non-corrosive material in ducts, as well as fans and discharge stack.

If any system of collecting and discharging the smoke at one central point is considered, this last mentioned seems to be the most practical and economical from an operating standpoint.

Another and fourth method which we understand has been experimented with by the University of Pittsburgh is to collect the smoke and discharge it through large flames in which has been applied a great number of copper wires charged with very high tension alternating current. The idea is that the waves set up by the high tension electric current will separate the soot from the gases.

It is understood that this system has been carried to a practical solution in connection with furnaces in ore smelting plants, but whether satisfactory results can be obtained with ordinary coal smoke as yet has not been determined.

During a portion of the time that the previous paper was being read Vice-President Hoffman relieved President Towner by taking the chair temporarily, after which President Towner again resumed the chair.

DISCUSSION.

PRESIDENT TOWNER: Are there any questions that any gentleman present would like to ask with regard to this paper?

THOMAS H. HAGGERTY, Chief Smoke Inspector, C. R. I. & P. Railway, Chicago, Ill.: I would like to have some of the gentlemen present explain not tests, but actual conditions and instructions as given to their firemen while in service, as to the manner in which they are to fire their engines, whether one shovelful at a time, two shovelfuls at a time, or ten shovelfuls on the fire; whether they are to swing the door between each shovelful, etc. I would like some of the members to tell us just the actual way they handle conditions, and let us get away from this 100 per cent proposition, and see what we can do to improve upon actual everyday firing practice.

M. D. FRANEY, M. M., Elkhart, Ind.: In employing firemen, say that we have to start in with a green fireman. There are times, as many of the members know, but some of the members probably do not know, when we would probably employ eight or ten new men in one day and put them in to firing. You will all agree that it is something of a problem to take possibly ten new men and put them right into the service, and have those men capable of firing a locomotive so as to come within the smoke ordinance.

When there is smoke violation, as you well know, we are not asked whether we have a new man that has only had one or two days' experience, or whether the man is a one-year, a two-year, or three-year fireman. We are told that we have made a violation, and that goes.

When we employ a fireman he is usually employed by a Road Foreman of Engines, and the new man is instructed as to the principles of combustion and what constitutes the making of smoke. He is instructed on the rules, briefly of course, and then he is given a letter and sent out on a trial trip—a letter to the engineer and to the regular fireman. He will make possibly one, two or three trips firing the locomotive under the direction of an experienced fireman and an experienced locomotive engineer. He is also instructed with reference to the signals and is required to call back to the engineer the signals under the direction of this experienced fireman. He is taught how to work the injector, how to work the blower, how to fire closely, putting one shovelful of coal on at a time as circumstances will permit. There may be times when the condition of the fire box with 54 to 58 square feet area would require more than one shovelful, and in that case he would fire more than one, but of course the door is always closed between the firing of each shovelful of coal.

After the man has made the first round-trip, we will say, over the division, the engineer will give him a letter which is presented to either the Round House Foreman or the employing locomotive Road Foreman of Engines, and the letter will say that he is improving and will require one, or two, more trips. After he has received a letter from the last engineer that he has fired with that he is capable of firing alone, and has received proper instructions, he is then put in the yard, unless the number of men employed warrants placing him on the road. But he must always be proficient and have acquired the necessary knowledge to successfully fire a locomotive and handle the appliances.

Even when he goes on the road the engineer in charge knows that he is a new man, and will require him to call the signals, and will instruct him if he gets out of line in firing the locomotive. The engineer will also watch him to see that he does not put in too much coal and produce smoke; if he does the engineer will put on his blower, and tell him what to do to eliminate smoke.

I would say, Mr. Chairman, before I sit down, just very briefly, that considering the large amount of information and instruction necessary to impart in the building up of a new fireman, our railroads certainly are very proficient in the instruction given, and very thorough in their instruction to new firemen, not only with reference to the avoidance of smoke violations, but with reference to the observance of rules for the prevention of accidents.

We try to surround ourselves with every safeguard, and where our attention is called to any method of improving these instructions, we are always glad to give it consideration, and if it is a good thing, to adopt it. In addition to this a fireman is given the Book of Rules and is required to study the Book of Rules and the Time Card. He is given what is known as the "First Year's Questions," and he is told that at the expiration of the first year it will be necessary for him to pass a written examination on that Book of Rules. He is not given the answers, he must look up the answers himself; although he is at liberty to talk to other enginemen or to his Road Foreman of Engines, or to any one of his superiors and ask where he can get the information. If he passes the first year examination he is then given a set of Rules that are known as the "Second Year's Questions," and at the end of the second year he is required to answer these. He is then given the "Third Year's Questions," and after the end of the third year he passes the third year examination, and if he then passes the Book of Rules test, he is promoted to an engineer.

President Towner: Gentlemen, our time is growing short. Our next number on the programme is entitled "How Smokeless Operation of Locomotives Was Obtained in Washington, D. C." This we had expected to be covered by a railroad representative from Washington, but no such representative is in attendance here, and Mr. Henderson has volunteered to give us a few words on that subject.

HOW SMOKELESS OPERATION OF LOCOMOTIVES WAS OBTAINED IN WASHINGTON, D. C.

REMARKS BY J. W. HENDERSON, DIVISION CHIEF, PITTSBURGH.

Last year I took a trip to Cleveland, Philadelphia and Washington, and the experience I had in Washington is mainly responsible for the pressure we brought to bear on our friends from Pittsburgh, because we found out in Washington, D. C., that they were giving smokeless operation. They were using some hard coal in locomotives, that is nut coal, some coke, and a little, 22 per cent, volatile bituminous coal, and the ordinary Pittsburgh coal.

Prior to the convention when suggestions were called for as to papers to be read here, and when they tried to discover the best line of statistics to have presented here, the suggestion was made that we get some one from Washington to speak on this subject, as they seemed to have set the pace. Letters were accordingly sent to the Superintendent of the Terminal Company, with copies to the President of the Pennsylvania Railroad and the President of the B. & O. Railroad Company. For some reason or other they were unable to present a paper covering the experience in Washington, D. C., and therefore, I am going to tell what little I can about it.

On my visit there I was taken in charge by a young man who has had jurisdiction over the smoke question, and he told me about the number of inspectors that they had—I believe eight—all taken from the different roads, stationed at various points, who make daily reports and monthly reports, the result of which has been that a kind of competition had arisen between the different railroads.

I was taken out to the different parts of the District of Columbia and had a chance to see locomotives operating under all conditions, coming in and going out. I observed locomotives fired with cold boiler, and noted that they did not make smoke enough to violate our law covering a locomotive in operation.

In one case we were sitting in a tower that I think they call the J. B. or J. W. tower, where the locomotives came in from the Bennings Yard and came through a tunnel, consequently climbing a grade to where we were sitting. We saw a heavy train of Gons and Hoppers loaded, with a big B. & O. locomotive, which had to stop half way up the grade and drift back the third time before it could start the load. As long as he remained in sight he did not make even No. 2 smoke. In order to be sure that there wasn't any hard coal or coke, or anything but bituminous coal on the locomotive, I went up as close as I could to it in passing, walked alongside of the engine to see how they were operated.

They have no smoke inspector in Washington, D. C., nor do they have any smoke ordinance at all, as I was given to understand; but it seems that Congress had up before it a resolution in regard to the probable necessity of forcing the railroads to electrify the District. It seems that the railroad officials decided that they could show that this was not necessary; and they have shown that it was not necessary sufficiently well, so that no action has been taken on electrification. I think that is sufficient to get into the record, the fact that Washington, D. C., a year ago at this time was setting the pace for all other cities in the country, so far as I can determine, especially the cities that I have visited, which were the prominent ones that were responsible for the production and emission of smoke.

President Towner: I have a little note here that says that a moving picture entitled "Smoke Abatement in Cincinnati," showing several tests of smoke prevention devices for locomotives and power plants, will be ready to show any time after three o'clock this afternoon at the Grand Opera House, on Vine Street between Fifth and Sixth, which is a square and a half from here.

The next paper on the programme is entitled "What the Railroads Have Done to Abate Smoke in Cincinnati," by G. H. Funk, General Railway Smoke Inspector, Cincinnati, Ohio. (Applause.)

G. H. FUNK, General Railway Smoke Inspector, Cincinnati, Ohio: Mr. President, I am glad I got the applause first, because I am afraid I will not get any afterwards. Your time is getting short, and I will not make any further preliminary remarks except to say that it is not a technical paper; and with that explanation I will go right ahead with it.

Mr. Funk's paper follows:

WHAT THE RAILROADS HAVE DONE TO ABATE SMOKE IN CINCINNATI.

G. H. FUNK, GENERAL R. R. SMOKE INSPECTOR.

While the smoke question had been under consideration for a long time in Cincinnati, the efforts to abate smoke, especially on locomotives, were spasmodic and not very much was accomplished towards that end until 1913, when action was begun along systematic lines in regard to the railroad side of the question.

In July, 1913, a meeting was called at the City Hall by the Chief City Smoke Inspector, which was attended by the Mayor, other representatives of the city and representatives from all of the railroads entering this terminal, at which time the question was thoroughly discussed and the result of which was the managements of the roads, through a feeling of civic pride and desire to assist the city in their very laudable efforts, organized the Railway Smoke Inspection Bureau, the expense of which was borne entirely by them, meaning quite an outlay in money per year, whose object, as indicated, was to devote its entire time and attention to the "smoke" question.

In addition to the Railway Inspectors, the City, under Chief Smoke Inspector Heath, have their regular force and the citizens by private contribution support a civic league called the Smoke Abatement League, of which Mr. E. S. Jerome is superintendent, and who also have a corps of inspectors, and we are pleased to say that from the first, instead of the antagonism that has been shown to exist between these bodies and railroads in some cities, our relations with both organizations have been the most cordial and we find them to have been very considerate in many ways.

The railroad situation at Cincinnati is peculiar to itself, inasmuch that the physical characteristics are such that a little smoke, even of light density, is accentuated and becomes objectionable and is cause of complaint, whereas, in many other cities such might not even be observed—the part of city where many of the yards are located and greatest congestion occurs, lays in a hollow or valley and at all times of the year, except in summer, possibly, the climatic conditions are such that the smoke question is aggravated and the railroads suffer through comparison.

Even on clear days the smoke of any density is objectionable in many parts of the city where the roads run at the base of hills upon the tops of which are residences.

In addition, the terminal situation is such that in several instances very heavy grades are met with immediately leaving the depot or yard, and as steam is necessary, our difficulties can be seen at a glance—one road has an ascending grade of 3½ per cent for 1½ miles from start, all of which means that to successfully combat the smoke, we must have our engines in good condition, properly equipped with adequate smoke consuming devices to assist the crew and most of all, we must have an engine crew well trained in their respective duties of running and firing the engines.

The Railway Inspection force expense is prorated amongst the different roads involved and the Inspectors neither report to nor are responsible to the individual roads but make impartial observations of all the locomotives coming within their notice and a daily report showing road, engine number, location, time observed and density of smoke emitted is made to the General Inspector, while violations are reported on a prescribed form and once a week a report is made to each road showing total number of engines observed, number of violations and comparison of same with previous week—in addition, a duplicate of the violation report is sent to the designated officer of road involved, the same day, for such disciplinary action as deemed best.

About every quarter the per cent of density is worked out and submitted to show status of each road, as we feel that a report of the violations alone would not fully give the situation, as one road may have several violations with its many other engines giving good service and have a low density, whereas another road with fewer violations might have more engines emitting more smoke and show a higher density.

The Railway Inspectors do not confine themselves to making observations but they note the offending crews and make it a point to ride with them at first opportunity to find out what is wrong, and as they are practical enginemen they note whether untoward conditions are due to mismanagement upon part of crew or fault of engine, which is at once taken up with the proper official and we have no trouble in obtaining a remedy.

Our force will fire the engine and demonstrate our suggestions in smoke abatement and we never ask the crew to do anything that we cannot do ourselves.

At certain intervals we begin a systematic riding of engines with view of riding every engine and with every crew on terminal and repeat instructions and demonstrate by actual practice what can be accomplished if the right effort is made and we feel that in our efforts towards smoke abatement that we have not only accomplished that but have effected fuel economy also.

We check the condition of the engines and the officials will agree that we have been of some service in reducing blows, flue trouble and leaky condition of fire box and in maintaining a generally bettered condition of locomotives, of which fact a General Superintendent publicly announced that partly through our efforts the locomotives on his road in this terminal were in better shape than they had been for years.

At the inception of the Smoke Inspection Bureau we anticipated a certain amount of aloofness upon part of the local railway officers, as the smoke question has heretofore been looked upon as a question of annoyance and one that would wear itself out in time, but we were agreeably surprised to see the hearty support accorded it by all and we would take this time for saying that the results obtained have mainly been through the support given by the local officers.

The success of any movement depends upon a certain amount of enthusiasm behind it with concerted action and to obtain this organization, the Master Mechanics, General Foremen, Road Foremen of Engines, and others interested, meet once a month to offer suggestions, listen to and discuss a paper gotten up by one of the members. The subjects are diversified from drafting of engines to combustion and we find them to have been of great value.

Failure in many ventures is frequently invited by the fellow being afraid of being laughed at and the one who is so afraid you can depend upon getting nowhere. The smoke subject at first, no doubt, was a joke to some, but I believe that point has now been passed.

The principal factors and best smoke consumer on a locomotive are a well trained and intelligent engineer and fireman, and while smoke consuming devices are being put on the engines, we try to impress upon the crew's mind that they do not mean license for improper handling or firing, but are intended simply as assistance in abating smoke.

Acting on this principle all of the roads began a campaign of instruction and instead, as formerly many times observed, a fire of from 10 to 15 shovels of coal being put in fire box at one time, the locomotives are fired in transfer service especially with the one shovel method, closing the door after each and seldom firing over three or four shovels of coal at one fire.

Different methods of firing are in vogue, but the one meeting with the most success is giving verbatim as issued as instructions by several of the roads.

PREPARING FIRES IN LOCOMOTIVES—ALL SERVICE.

Before leaving the engine house territory, the fire should be supplied with sufficient fuel, using small quantities to avoid black smoke until there is a moderately heavy bed of coked coal over the entire grate surface. The blower should be used continually during this operation, leaving the furnace door slightly open if necessary.

SWITCHING SERVICE.

When engine is in service, the charges of coal should not exceed two (2) scoops at a time, firing on alternate sides of grate surface with such frequency as the service performed by the engine may demand. To avoid emission of smoke, the smoke preventing device should be used and the furnace door left slightly open.

FREIGHT, PUSHER AND PULLER SERVICE.

In firing freight, pusher or puller engines, the charges of coal should not exceed three (3) scoopfuls at a time and to be fired the same as described in switching service.

PASSENGER SERVICE.

In firing engines in passenger service, the light engines in passenger service should be fired with not more than two (2) scoops of coal at one charge, and the heavy engines in heavy service, not more than three (3) scoops of coal at a time, and fired in the same manner as described for switching service.

IN ALL SERVICE.

A sufficient bed of coked fire should be maintained at all times and kept burning bright, and the steam pressure should not be allowed to fall below maximum pressure to exceed ten (10) pounds.

Engine should be operated in such a manner and every precaution taken to avoid unnecessary slipping of the drivers and otherwise avoid tearing of the fire.

If necessary to shake the grates, rake or stir the fire, the smoke prevention devices should be used with the necessary force to avoid the emission of smoke.

DRIFTING INTO STATIONS, DOWN GRADE, ETC.

In all cases just before the steam is shut off, the smoke consuming device must be used.

Good judgment and intelligence are necessary to make a good fireman, but there is one attribute he must have or he will not succeed, and that is good judgment, and while it is possible that he may become a skillful fireman without a technical knowledge of combustion, some information is essential, and to furnish this most of the roads have gotten out books which are issued to the men, treating upon combustion in an elementary manner, sufficient to show how to overcome many of the difficulties and shows the economy of smokeless firing by obtaining the heat from the gases which are burnt in firebox instead of being allowed to go out of the stack as smoke.

The engineer is not overlooked, as he should insure proper handling of the engine and if he is careless and takes but little interest in the work the fireman is apt to follow his example and become as careless as the engineer.

To run an engine economically means that the feed water is being pumped to boiler with regularity as boiler demands it, engine not to be worked full stroke longer than necessary, and to be "hooked" up as quickly as possible, and when conditions warrant it to run with a short cut-off and full throttle, avoid unnecessary slipping of engine account of wear to machinery, waste of fuel and tearing holes in fire, see that engine is properly drafted so that draft hits the fire evenly, run with as large a nozzle as will make steam, be sure to report all blows, stopped up flues, leaky joints, or any condition that may cause engine to steam badly, all of which have a bearing on the smoke question.

All of the roads, with one exception, use high volatile bituminous coal and it was found necessary to equip the locomotives with some device that would assist in abating the smoke and after exhaustive tests it was decided that air induction tubes, arches, double or multiple tip blowers and openings in fire door gave the best results, therefore same have been adopted as a standard with excellent results.

The first engine with 90x75-inch firebox was equipped with six tubes to each side sheet, staggered, 65-inch arch with 16 inches between top of arch and crown sheet and 5-inch spacing in center between arch and flue sheet, 1¼-inch blower line, "ring" blower of 15 tips with $\frac{3}{16}$-inch opening in each and 2½x6½-inch opening in door with deflector on inside—the steam line to air jets is ¾-inch with $\frac{3}{16}$-inch steam jets centrally located in tubes.

Most of the roads have gone to long arches with view to getting all of the benefit possible of increased travel of the gases in firebox to insure the mixing effect of the air and gases and better combustion and in some cases the arches are solid against flue sheet.

One road, in addition to equipping their engines with air induction tubes in the side sheets, on certain types of locomotives install the tube openings on boiler head instead, which is covered by an iron hood that runs down and has the air admissions below the deck of engine, the whole being covered by asbestos lagging, and others are so equipped in addition with the arch, all of which give very good results.

At the beginning of the smoke crusade it was recognized that the question of smoke consuming devices should be handled in a systematic manner and as such good results have been obtained with appliances mentioned, they have been accepted as a standard; therefore, we are not troubled with one road having certain devices and another with a different kind.

With an engine thus fully equipped there is absolutely no excuse for excessive smoke either while standing, drifting or using steam, pulling a heavy load, and this condition has been obtained without change of fuel.

Frequent tests in which the city authorities participated have been made of which several, as examples, will be cited.

B. & O. 1570 was photographed by representative of the Times-Star, while engine was pouring forth dense smoke after 10 shovels of coal were thrown in on a bright fire and was then "hooked" over. It took the photograph 8 inches to change the plate to show a clear stack, which was obtained in 5 inches after blower and jets were turned on. This test simply demonstrated the work while standing or drifting.

C. & O. 477, handling 45 cars of coal of 3,150 gross tons from Fourth Street Tower to Ivorydale, a distance of 8 miles, was under observation of the Chief City Smoke Inspector and his report shows that at no time was smoke observed of greater density than No. 2.

L. & N. 925, handling 42 loads and 9 empties on same as preceding run, also under observation of the Chief City Smoke Inspector, who reports that in entire distance smoke equalling a violation was only observed for period aggregating 45 seconds.

These special engines are not selected as being the best but are just an example of what can be done with most of the engines on all of the roads on our terminal.

In fighting "smoke" the railroads have given the question of air admission through the ashpans and grates their consideration and many locomotives that formerly had tight ashpans have had them dropped at the mud ring, a distance of from 3 to 5 inches, with openings in side, covered with screens.

The question of nozzles has also been given attention and most of the roads on this terminal have gone to large nozzles and enlarged them to the limit that will permit steam—to increase them to such size as will create too light a draft and engine will not steam, the very opposite effect will be obtained and more smoke will be made, due to the frequent disturbing of the fire by being hooked over to make the coal burn.

A definite sized nozzle for all engines of the same cylinder cannot be given, as the kind of coal used, drafting of engine, etc., are a big factor in such determination, but we find the best plan is to use as large a nozzle as will generate steam and less smoke will be produced, as a lighter fire can be carried and better combustion obtained by a free access of air through the grates and firing will not have to be so hard nor frequent.

Other advantages are, with a large nozzle the draft is not so violent and the gases travel at a slower speed and lay longer in the tubes, thereby giving up a greater portion of their heat, and on account of the milder draft permits the fireman to keep his fire in shape and from having holes torn in it and the smaller quantity of fuel fired means less gas to be distilled and burned, therefore, less smoke.

A larger nozzle can be run with good results on an engine in short switching service than can be on one in long protracted service where a uniform steam pressure is required.

We find, also, that as a rule, when arch is used that a larger nozzle can be used with excellent results.

One of our roads especially has gone into this question exhaustively and increased the size of nozzles on certain engines from 4⅞ to 5¾ inches with result that they show a fuel saving of 17 pounds per engine mile for their many yard and transfer engines.

The proper drafting of the engines is watched closely to see that fire burns evenly and over as much surface as possible in firebox with view of utilizing every heat unit possible by distributing the gases through all of the flues.

As the Round Houses were a prolific source of complaint, this feature of the work was entered into and we can safely say that there has been a reduction of 80 to 90 per cent of smoke from this source alone, by improved methods of firing up. The method pursued is to place coal in firebox to depth of from 4 to 6 inches in center and sloping the coal upwards at sides and using wood or oil soaked shavings to start fire from the top.

On some of the roads which use a harder coal the entire surface can be covered with wood or shavings and engine fired up without a violation, while on others, which use a very friable coal, more care must be exercised and from one to three shovels of shavings soaked in from 1 to 2 pints of oil is thrown to front of firebox, covering a space of from 1½ to 2 feet from throat sheet and fire gradually extends back over the entire surface, distilling the gases slowly and from small quantities of coal at a time.

We find that the one essential with all the other methods pursued is a good house blower, giving both volume and pressure of steam and experiments between the use of single and multiple tip blowers in building up fires convinces us of the superiority of the latter.

As just as much complaint could arise from the smoke from the stationary plants as from the locomotives, this phase of the question was considered and corrective measures applied. At some of the Round Houses stokers have been applied while at others pier walls have been built in combustion chamber, arches and air induction tubes with steam jets installed, the latter being installed upon minimum basis of one 2-inch tube opening for every 250 square feet of heating surface or fraction thereof, being careful to have the tube in such position that the air injected would be on a line to hit about 6 inches from the grate line at bridge.

At several of our power plants horizontal return-tubular boilers are used with installation of arch and side induction tubes.

In addition to their regularly assigned Smoke Inspectors, the Cincinnati Railways have instructed their Superintendents, Train Masters, Road Foremen of Engines, Yard Masters and others, in official capacity, to report smoke violations, and they have assumed these duties in good faith as the many reports turned in by them indicate, and some roads have Road Foremen of Engines assigned to terminal duties alone and we must say that they are getting wonderful results.

The city uses an umbrascope as gauge for density of smoke, while the railways use the Ringleman chart with No. 3 as lowest density constituting a violation.

The Railway Inspection Bureau averages from 750 to 800 observations per week, and a result of the work, in comparison with first seven months in 1915 with 1914, is herewith shown to indicate the improvement made in per cent of violations, i. e.:

1914.		1915.	
January	9.1%	January	3.4%
February	7.7%	February	2.6%
March	9.4%	March	2.6%
April	9.9%	April	3.6%
May	12.3%	May	1.5%
June	9.7%	June	2.9%
July	7.1%	July	1.4%

As the density is the foundation of the question, would say, that in November, 1913, two months after we began the work, the average density of smoke of the roads was 30.8 per cent; February, 1914, 24.8 per cent; October, 1914, 20.9 per cent; March, 1915, 18.5 per cent, and August, 1915, 16.4 per cent.

The most decided improvement in smoke abatement on the railroads has been made within the last year, but we are not satisfied to simply avoid violations but are watching the fellows who make a great deal of smoke and still keep within the confines of the law and are after them to still further reduce it. The man who is conscientious, and is successful in his efforts to prevent an unnecessary amount of smoke, receives proper credit and praise, while the one who exhibits carelessness is disciplined, according to the gravity of the offense.

Smoke abatement and fuel economy are synonymous and you cannot get away from the fact that when you obtain the first, in an intelligent manner, the latter is bound to result.

With advent of side induction tubes, long arch and large nozzles, one road has been able to show a saving of 102 lbs. engine hour, another that just began to equip their engines last March makes the following showing, i. e.:

1914.		1915.	
March	166	March	144 lbs. coal per eng. mile
April	155	April	141 lbs. coal per eng. mile
May	172	May	124 lbs. coal per eng. mile
June	144	June	108 lbs. coal per eng. mile

A superintendent on another road advises a saving of 13 per cent in fuel.

We have a great many superheaters in switching service, but in the writer's opinion the only cause of their smoking less is due to the fact that less coal is fired.

We again wish to lay stress on the fact that we consider the engine crew the greatest factor for smoke abatement, as a good fireman on a poorly equipped engine will have less smoke than a poor one on engine with all the latest appliances.

A concise statement of our devices for smoke abatement are sufficient air openings in ashpan and grate, properly drafted engine, as large a nozzle as will permit steam, arch long enough to insure good combustion, 1¼-inch blower line, a double or multiple tip blower and sufficient air openings in the firebox to insure sufficient air for combustion.

FOURTH SESSION—THURSDAY NIGHT, SEPTEMBER 9, 1915.

The Convention met pursuant to adjournment, President Towner in the chair.

The first order of business is the adopting of the standard of density, action on which was postponed yesterday until eleven o'clock this morning.

Secretary Viall: Mr. President and Gentlemen: In view of the fact that the percentage of density or standard of density to be considered satisfactory is not generally known among several of the cities, and some of them feel that five per cent or any other specific figure is more or less misunderstood by them, I therefore move you that the supplemental report of the Committee on Standardization on Densities be adopted as to the methods of making the readings, but that no figure be inserted as to what standard of density shall be considered as indicating satisfactory performance.

The motion was seconded by Mr. Rooney, and stated by the Chair, who inquired if there were any remarks on the motion.

A Voice: I was not here at the time that this was called up, and I would like to know what is meant by standardization?

President Towner: The report of the committee was read yesterday morning. Mr. Viall, can you enlighten the gentleman?

Secretary Viall: The report referred to the establishment of methods of reading to arrive at average smoke density; and in the report there is a statement to the effect that a furnace to be considered satisfactory must operate with an average density of five per cent or less. Many of the cities have said that they thought five per cent too low a figure; others did not know whether five per cent, ten per cent, or what percentage was adaptable to their condition, and it has been thought advisable to delay for a year before this Association goes on record as to what density should be considered performance, but that the scheme or method of finding this density as recommended by the Committee be adopted.

President Towner: Is there anything else to be said on the question? (Cries of "Question!")

The question was now taken on the adoption of the motion as above, and the same carried.

PRESIDENT TOWNER: The next order of business on the program is entitled, "Special Furnace Applications in Manufacturing Processes," by Joseph Harrington, Consulting Engineer, Chicago, Ill.

JOSEPH HARRINGTON, Consulting Combustion Engineer, Chicago, Ill.: I have never been noted for my particularly weak voice, and I hope it will not fail me tonight.

The request which I received from your Secretary for a paper this evening carried with it the title of "Smoke Abatement in Special Furnaces," and I wrote this little paper on that subject; and I think perhaps it is a little more applicable to what I have in mind than the title to which your President has just read from the program. On account of the circumstances surrounding a paper of this kind, I have boiled it down to the limit, hoping that the details would be brought out in the discussion rather than attempting to elaborate on all the points in the original paper. Not only that, but it is more or less of a theoretical treatment, and I know that you are not anxious for too much of this theory business. But after all it is the theory that underlies all of your practical attempts, and whether you recognize it or not, you are merely endeavoring to apply correctly a fundamental theory of combustion.

The special furnace problem is altogether too great for me to attempt in any reasonable time for specific illustration, because I would have to present an almost infinite number of rather complete details, and that would make the proposition so elaborate and so voluminous as to be entirely out of reason.

The speaker then proceeded with his paper, as follows:

SMOKE ABATEMENT IN SPECIAL FURNACES.

BY JOSEPH HARRINGTON, CONSULTING COMBUSTION ENGINEER, CHICAGO.

A consideration of the problem of abating smoke in special furnaces necessitates a preliminary examination of the character of the combustion conditions which obtain therein. These furnaces naturally fall into two general divisions, based on the character of the flame or gaseous product of combustion used in obtaining the heat for the metallurgical process. Type "A" includes those furnaces wherein combustion is carried on for the sole purpose of generating heat, it being a matter of indifference of what chemical nature the flame may be. Type "B" includes those furnaces which, while primarily heating furnaces, necessitate a flame which is devoid of oxygen. In the former class we find such furnaces as are used for evaporating or drying substances in vessels, such as driers, stills, ovens, brick kilns, muffles and gas benches. In the latter class we find malleable iron melting furnaces, sheet steel heating furnaces, forging and puddling furnaces, annealing ovens, etc.

With Type "A" furnaces the problem is practically the same as the problem of smokeless combustion in boiler furnaces. Either on account of the gases not coming into contact with the substance treated, or, if coming into contact, on account of not affecting it, an excess of oxygen is permissible. Oxidation of the fuel can be carried to completion. In this type of furnace an excess of oxygen is a practical necessity on account of the limitations of modern furnace design. By reducing the amount of excess air the temperature of combustion increases, and also the efficiency, if the furnace permits of proper mixing and time for complete combustion. Since heat is generated to be absorbed, it should all be developed before the object to be heated is reached by the gas resulting from the combustion; otherwise, the colder substance cools the gas and checks combustion. Also the delayed combustion causes less heating surface to remain for contact with the gases and reduces the capacity of the apparatus. Obviously, therefore, adequate furnace space is required, with the accompanying conditions of high temperature, sufficient air and opportunity for complete mixing and oxidation. With all the facilities now known for securing complete combustion with the minimum loss by excess air, little excuse can be offered, other than that of cost, for not having the most efficient installations. There are stokers of many kinds and sizes, some one being adaptable to almost any of the special furnace problems of this type. It is a point which should be emphasized, even though it has become almost an axiom with combustion engineers, because there are an enormous number of these furnaces in use; and if changes later on referred to be adopted, there will be a still greater number.

The problem involved in the furnaces of Type "B" is much more difficult. The nature of a reducing flame is that it has insufficient oxygen and the hot gasified hydrocarbons call loudly for more oxygen. This is a de-oxidizing flame, and when it comes into contact with iron oxide, has a tendency to extract the oxygen therefrom in order to satisfy its own demands for more oxygen, and leave the iron in the metallic state. For this reason it is necessary in certain metallurgical operations, but as I will mention hereafter, is not the necessity that it has been commonly understood to be. In the majority of these cases the contents of the furnace—usually some form of iron or steel—start out in a certain condition of surface cleanliness that it is desired should be maintained. The use of a reducing flame, therefore, is more for the purpose of assurance against oxidation than for any definite de-oxidizing action.

The control of shovel-fired furnaces in the matter of exact flame characteristics is so uncertain that a wide margin of safety must be maintained; and, in order to avoid the possibility of the gases carrying excess oxygen, a definitely de-oxidizing flame is produced. If, however, certainty of control were assured, a narrower margin would be permissible. Theoretically, a flame to be non-oxidizing need not be distinctly de-oxidizing; a perfectly neutral flame would serve. The product of perfect combustion of carbon containing only CO_2 and N would be such a neutral flame, and would, therefore, serve the purpose satisfactorily. That such a condition would carry a series of important consequences makes it worth while at least to consider the possibility of securing it. No definite amount of CO is demanded in these gases, but assuming 10 per cent as representing a highly reducing flame, the loss due to incomplete combustion is 33 per cent. Not only does this loss exist, but of more interest to this convention is the fact that this condition of partial combusion is the most prolific cause of the production of smoke. The answer to the problem of reducing smoke in Type "B" furnaces, therefore, would seem to be the controllable reduction of incomplete combustion. As a practical answer to the question of how to secure such control over the products of combustion, I have to suggest two general types of fuel feeding.

The first type involves the use of the underfeed mechanical stoker, which has as its most important characteristic the carrying of a heavy fuel bed and means for forcing air therethrough. Incidental to the type of fuel bed is the introduction of the fresh fuel below the layer of incandescent coal, so that the most complete extraction of oxygen can be obtained. The well known series of reactions in the case of a thick fuel bed need not herein be repeated, the fact alone being of interest that the amount of excess air in the flue gases is under definite control. It is my understanding that, if desired, this type of stoker can actually be used like a gas producer; that is to say, by sufficiently increasing the thickness of the fuel bed or reducing the air pressure, a true producer gas can be obtained. This is a gas carrying high percentages of CO and a complete absence of free oxygen. By virtue of the complete control over both coal and air supply and the absolute uniformity in the supply of both of these substances, gas analyses can be continuously obtained with virtually no excess air and at the same time with practically no loss due to the presence of CO.

The second means of securing the required control over the analysis of gases is by the use of powdered coal. From a strictly theoretical standpoint, this is one of the prettiest propositions that now engages the attention of combustion engineers. Briefly, the requirements are these: the coal must be dried so as to contain not to exceed 1 per cent of moisture; second, it must be pulverized so that 90 per cent will pass through a screen of 200 meshes to the inch; third, it must be uniformly and controllably mixed with the air requisite for its combustion just previous to injecting it into the furnace; fourth, the design of the furnace must be made with a definite view to securing a control of the ash deposit, the gas velocities and the resultant temperature, that will be in accord with the requirements of the furnace or the metallurgical operation under consideration. That powdered coal can be successfully and economically burned has now been demonstrated, as also its definite economy as compared to its nearest competitor, crude oil.

It is not timely now to enter upon a complete analysis of the use of powdered coal as a fuel, but as regards the production of smoke, I wish to call your attention to those conditions which were touched upon in considering underfeed stokers.

The finely-divided condition of this fuel means that combustion can proceed with the utmost rapidity, and when the cloud of dust is blown into the furnace with the right proportion of air each minute particle of coal is surrounded by just the amount of air required to burn it. It will burn with a dazzling white flame, completely and rapidly, evolving a temperature so high that in former times difficulty was encountered in controlling it. It has, however, now been adapted to many metallurgical processes with the utmost success, and those who have installed and operated this system are the ones most enthusiastic as to its economy, smokelessness and flexibility.

Another solution of the Type "B" problem is the use of the muffle kiln wherein the gases do not come into contact with the metal being heated. This really makes it a Type "A" problem, but it is applicable in a great many more cases than heretofore considered possible. Muffle kilns are not considered particularly economical, and have been used only in those cases where it was vital that the gases should not touch the contents of the furnace. This applies particularly to glazed terra cotta, enameled iron ware, bathroom fixtures, etc. There is now on the market, however, a muffle furnace of scientific design wherein the efficiency of the entire outfit is unquestionably equal to the direct-fired furnace, and the quality of the metal coming from this type of muffle is superior to that heated in the older form of furnace. From the standpoint of smoke abatement it is all-important, because a furnace of adequate size can be built and any one of several smokeless furnaces installed.

True economy in any kind of furnace demands the utilization of the waste gases, and while this is not directly a smoke abatement problem, it is recognized as aiding the work of the smoke inspector if convincing evidence can be given to the factory owner that the change suggested by the inspector carries with it not only the abatement of the nuisance, but a distinct saving due to the scientific design of his furnace and the complete utilization of the heat. Temperatures up to 2,500 degrees Fahrenheit can be maintained in this kiln, with complete exclusion of outside air, thus making it especially applicable to annealing and malleablizing ovens, rivet heaters, heating furnaces in sheet, wire and tin plate mills, etc.

Illustrations of installations embodying the principles which I have outlined are not entirely satisfactory in connection with a paper of this kind, on account of the infinite variety of conditions which are encountered. Each case must be studied on its own merits, simply remembering the fundamental requirements and applying them to the particular case.

Encouragement is had in the definite opinion of experts that smoke production is not only unnecessary but preventable, and that when scientifically abated, economies of magnitude have resulted. It may be necessary to entirely remodel the furnace or adopt a different type, but the saving in fuel due to the proper selection of design and operation will soon offset any reasonable expense that may have been incurred in the installation of the new equipment.

After completing the reading of the foregoing paper, Mr. Harrington remarked as follows:

Now I want to add a few remarks extemporaneously. At the risk of repeating what I have said in the paper, I am going to ask your indulgence for another minute or two simply, as they say, "To rub it in," if you have no objection.

The point of the whole matter which I have endeavored to set forth is merely that with the utilization of equipment which today is acknowledged as a definite commercial success, complete and efficient combustion can absolutely be secured. There is not any question in any one's mind of our ability to burn up all of the smoke-forming materials in a well designed boiler furnace. In such metallurgical processes as can stand the presence of excess oxygen, it is simply a question of adapting the well known principles of boiler furnaces thereto. In types of furnace like heating furnaces wherein it is not permissible to scale the metal, the point I make is this, that the only object in carrying a long mellow reducing flame is the prevention of oxidation of the metal or "scaling" as they call it, and that the deoxidizing or reducing flame is merely a measure of precaution against the presence of the destructive oxygen; but that if a perfectly neutral gas can be developed you would prevent equally well injury to the metal, and at the same time secure all of the benefits due to the complete and mechanical combustion of your fuel; and of course that proposition carries with it the absolute absence of smoke.

Heretofore the equipment which has been utilized has been so crude, so uncertain, that they have had to carry a flame having a wide margin of safety; but today I contend that with the refinement of the present day stoking equipment and with the knowledge of what constitutes complete and efficient combustion, that it is no longer necessary to waste twenty-five, thirty or forty per cent of your fuel to safeguard yourself against injury in the furnace; that if you burn the coal completely you will also burn it efficiently, and you will also burn it in a manner not injurious.

Now the very fact that this is not particularly easy is no argument against trying it. The fact that it has not been heretofore done is not only no argument against trying it out, but is a very good reason why you should experiment with it if it bears on its face evidence of good sense and reasonableness.

I was tempted this morning to ask for the floor in order to add a word to the discussion on Locomotive Furnaces, because it seemed to me too bad that the Locomotive Session of this morning should have ended without this Association going on record in any way as recognizing the powdered coal proposition. I am not going to bore you now with any rehearsal of that; but it is something that is going to be more and more interesting and important from every standpoint; and I have the temerity to suggest to the Association that some committee be appointed that can follow along with the developments of this very important phase of combustion engineering, and be prepared at your next session to give you a complete, up-to-date, accurate presentation of this subject. I thank you. (Applause.)

DISCUSSION.

PRESIDENT TOWNER: Has any one any questions he would like to ask Mr. Harrington?

WILLIAM MITTENDORF, Cincinnati, Ohio: I would like to ask Mr. Harrington, Mr. President, if in powdered coal operation there has been any provision made for consuming the slag resulting from the burning of the powdered coal? Has any device been invented yet that can handle that slag?

JOSEPH HARRINGTON, Consulting Engineer, Chicago, Ill.: That has always been and is now one of the difficulties. In order to adequately answer the question we must again analyze the situation briefly, because powdered coal is operated in two ways. It is burned in such a furnace as a malleablizing furnace, where they want a long, slow, mellow reducing, or deoxidizing flame, and they burn it with a deficiency of oxygen and consequently at a figure something like 1,700 or 1,800 degrees, which is below the fusing point of the resulting ash, and consequently the ash is nothing more than a light, fluffy powder that settles over the pots, or gets into the flues, or is carried out through the stacks.

If, however, you have got, we will say, a heating furnace for billets, where they want 2,500 degrees or more temperature, which is above the point of fusion of the ash, the ash is melted and is liquefied in that particular case, the liquid slag being in the form of microscopic particles which settle over the billets as they are drawn out, and is hoed off the hearth later on, and does no particular harm. The real problem of ash control is in steam generating propositions in the boiler, and that was the stumbling block for years. It is my understanding that they now have it under reasonable control in this way: By making a very large combustion chamber and by introducing fuel at a very low velocity, and by having a sharp turn in the path of the gases, the resultant slag or ash spreads out in the bottom of the combustion chamber into a relatively cool zone where it can be hoed out or broken out, or if it solidifies before contact with anything, it will fall out of a hopper-shaped receptacle. They have introduced pulverized limestone in certain cases for the purpose of fluxing the ash, and taking it out like slag out of a cupola; but that appears to be a very unsatisfactory way of handling the refuse from a boiler furnace.

The people that have agitated the use of this fuel in steam generating units are the very ones that do not tell you all about it. We have to assume certain things. We know what is done in metallurgical work, and that is a definitely demonstrated proposition; but I am very frank to say that while the thing is interesting, it has not reached a stage of any definite certainty as yet.

J. VAN STEYN, Haven Malleable Castings Co., Cincinnati, Ohio: I am connected with the Haven Malleable Castings Company. It appears to me that in our annealing furnaces if we used powdered coal it would be an awful proposition to get it out of the bottom of the flue.

JOSEPH HARRINGTON, Consulting Combustion Engineer, Chicago, Ill.: That is exactly the same trouble that the International Harvester people have had at the McCormick Works at Chicago. They have eight large malleablizing furnaces and they have burned powdered coal for years. They have had a great deal of trouble with ash getting into the flues exactly as you say; but I believe they have solved that problem by putting in an ejector steam ash handling system. It is not slag, but is a light, fluffy ash and can be taken out of those flues in the same manner as in a steam ash handling system or vacuum cleaner. I believe that is the way they have solved that problem.

J. VAN STEYN, Haven Malleable Casting Co., Cincinnati, Ohio: What is the draught over the fire from a Murphy annealing furnace in your experience?

JOSEPH HARRINGTON, Combustion Engr., Chicago, Ill.: It is practically nothing. The furnace is substantially neutral. The burners that the International Harvester Company use are just ordinary central screw feeders, feeding the coal from the bottom of the hopper, which contains the powdered coal. Even though that coal is perfectly dry, it is not absolutely floated, and the turning of a screw causes an intermittent feeding of the fuel, a pulsating effect; and during the time when the little inrush of fuel takes place, there is a miniature explosion. I have seen the flames shoot out of the inspection hole at the far end of the furnace during those momentary periods. I think the actual draught would show probably zero.

PRESIDENT TOWNER: Gentlemen, if there is nothing further, we will proceed to the next paper, "Enforcing a Smoke Ordinance," by Mr. S. H. Viall, Chicago, Ill. Mr. Viall will entertain you at this time.

S. H. VIALL, Secretary, Chicago, Ill.: Mr. President and Gentlemen, my connection with the Chicago Smoke Department for a period of more than five years taught me that there were many simple questions asked from cities considering the enforcement of smoke ordinances, or considering new policies in the reformation of the ordinances that they already had; and when I was asked to write a paper on the subject of Enforcing Smoke Ordinances, I went over much of my correspondence and selected a number of points that had been answered in letters addressed to parties making inquiries. The paper, therefore, is of primary interest to cities just starting the enforcement of smoke ordinances, or cities considering the problems of smoke inspection.

Mr. Viall then proceeded with his paper as follows:

ENFORCING A SMOKE ORDINANCE.

BY S. H. VIALL.

Public sentiment is causing owners of smoking chimneys to improve conditions, smoke ordinances and public smoke inspectors being the expression of that feeling. The effect of this sentiment is apparent in many of the small towns that have only one or two factories. Citizens have asked the village authorities if something could not be done to stop the excessive smoke. The village officers have taken the matter up with the factories, who in turn have given the subject serious attention and in many cases have decidedly reduced their smoke production.

Many of the larger cities have laws restricting the character of smoke that may be produced. The wording of these laws varies greatly and in given cases possibly limits the benefits that might be had. The methods of enforcement of a law usually are more important than the literal provisions embodied in the wording of the act. A clever man, who is agreeable, diplomatic, thorough, and well posted in the practices of burning fuel, entrusted with the enforcement of smoke regulations can be a benefit to a community and get results in spite of a poor ordinance.

Proper enforcement of good smoke regulation laws will not eliminate smoke, but will greatly improve the conditions, as compared with what they usually are, without legal restrictions. Authorities of some cities having smoke ordinances make no effort to enforce the requirements unless complaint is made by citizens against a given stack or group of stacks. If the complainants are sufficiently insistent and persistent they may cause an investigation to be made which might possibly result in some small improvement that is liable to be only temporary.

Generally the public assumes, after a law has been enacted and some one has been assigned the task of enforcing it, that their paid servant will go ahead with the work assigned to him without further prompting from them. Most people either forget or do not realize that their servants need encouragement and support if the best results are to be had from their laws. The smoke inspector is in special need of support by the public.

This paper will mention briefly some of the points that should be given careful consideration by those charged with the enforcement of smoke ordinances. The material presented has been gathered from the experiences of several successful public smoke inspectors.

Enforcement of a smoke ordinance depends upon public sentiment and the ability of the smoke inspector to handle the technical side of the work in an intelligent and diplomatic manner. The owner of a smoking chimney will usually contend that there is some unsurmountable difficulty in his particular case.

An inspector tells of being summoned before the mayor of his city to answer the complaints of a plant owner, who was objecting to the height of 90 feet for a stack that the inspector had recommended. The owner had with him a man represented as an expert stack builder who claimed the inspector was unreasonable. In fact, so much so that the inspector was asking for a stack that he (the contractor) could not build. The inspector informed the mayor that it was quite probable the man could not build the stack desired because he was a tinner, who possibly had put up a few extensions on house chimneys.

The demand of the public that chimneys smoke less has placed upon the smoke inspector the task of changing the habits and the line of thought of many thousands of firemen, engineers, owners, managers, superintendents and others. When we stop to realize the effort that is required of an individual who, of his own volition, has decided he will change a given habit of his own, of long standing, then we can appreciate the stupendous work assigned to the smoke inspector. For generations every one has been familiar with the smoking chimneys of manufacturing industries that used bituminous coal. Most of the men connected with these industries have through the generations come to look upon the production of smoke as a necessary accompaniment. This belief is partly due to the widely varying characteristics of the fuel found in different sections of the country, which has handicapped the spreading of general knowledge of the methods to be adopted for smokeless operation. The principal cause, though, for the lack of general knowledge of how to burn bituminous coal without excessive smoke is due to the fact that working conditions around the fires are very laborious, on account of the heat, dirt and heavy physical work. Conditions such as these do not promote careful study but cause men to endeavor to get into other lines of work and to follow the line of least resistance by avoiding or neglecting extended research under commercial conditions.

Clearly, one of the most important phases of the work of the smoke inspector is to educate all parties having anything to do with the production of smoke, and to prevail upon them to continually and intelligently study their problems. It is characteristic of man that he will try to adapt himself to conditions for which he sees no apparent remedy. Under the old methods of handling fires in large railroad roundhouse, the building was usually filled with smoke and noxious gases to such an extent that the men working there could not see readily and were compelled to feel their way around. Occasionally some one would be overcome with smoke and have to be carried out.

The enforcement of a smoke ordinance compelled the railroad company to make a careful study of conditions at the roundhouse and devise methods of handling the fires so as to avoid trouble with the city. Besides decreasing the smoke from the Jacks, complained of by the authorities, there was, incidentally, a marked improvement inside of the house. The men can now see readily and no one is overcome by the gases. A foreman at the place expressed his appreciation of the improvement by saying: "To think we tolerated the old condition so many years." This example is only one small incident, but it illustrates the fact that enforcement of smoke ordinances that cause owners to give thoughtful attention to their coal-burning equipment is a benefit to them as well as to the public.

Best results from the enforcement of a smoke ordinance can be had when the heads of the firms or companies affected give the movement active support. If it is known that the president of the company really wants everything possible done to improve smoke conditions of his factories, the lower officers and employes down to the fireman will try. Because they all know that their positions depend upon convincing the head of the company that they are carrying out instructions.

On the other hand, if a management in control of a smoking chimney is in the habit of dealing evasively with public officers, or is in the habit of using political influence in their efforts to gain special treatment for themselves, the smoke inspector will find the same attitude reflected in the engineer and fireman.

The successful smoke inspector must be a student of human nature as well as of smoke abatement equipment. He must be industrious, energetic and patient. He will find abundant need for an all-abiding patience and an everlasting stick-to-it-iveness in dealing with the contending interests. He will be continually called upon to "Tell me exactly what I can do at my plant." The way his advice will be received will occasionally be humorous, but more often aggravating.

Advice to plant owners as to what it is possible to do in a given case in order to stop their smoke should come from one whose training and experience have been broad enough so that his judgment in the case is reliable.

Reliable technical information that is to be had on the subject of the smokeless burning of bituminous coal is very meager. This, coupled with the fact that fuel characteristics vary with each locality, causing special problems, should be sufficient reason for permitting the smoke inspector to devote his whole time to the work of smoke abatement.

When an inspector is called upon to make recommendations for alterations to furnace equipment, with the idea of putting a plant in shape to operate smokeless, he must be very careful to be certain that if his recommendations are followed it will be easy for the average operating crew to handle the plant without objectionable smoke. Owners and their advisers will sometimes take exception to the recommendations offered, on the ground that they are more sweeping than are needed, for the results sought. In cases of this kind it is necessary to work with them and devise a scheme whereby such work as they do will be a benefit and a part of a general plan of improvement to be executed step by step. An inspector is often tempted, considering the financial condition of the owner, or because of difficulties encountered on account of the construction of the plant, to make recommendations for alterations that are of doubtful merit. He should be very cautious in prescribing anything that may not prove completely satisfactory. Many owners who spend money upon alterations to their equipment, in an effort to improve smoke conditions, will take the position that they should not be called upon to do more, even though their stacks still prove to be bad smokers. If the smoke inspector recommended the alterations, the owner will say: "Well, I have done all you asked of me." If changes, that proved inadequate, were made during the administration of a former inspector, the owner will say: "I spent a lot of money and did all your predecessor asked for; now you come along and want me to do that work all over again and spend more money. What assurance have I that the next man will not have different ideas from yours, and want me to go through the whole thing again?"

Any one recommending alterations should consider the kind of attention the plant will receive and remember that he will be blamed if results are not as desired. Seldom can the owner or public be convinced that the fault is with the operation and not with the equipment.

While construction or alteration work is under way, changes may be made in design or dimensions that handicap the equipment, either in ability to develop the work required or in the effect upon smoke. At times it is difficult after a furnace is completed and fired up to determine just what is the caüse of some faulty performance. Usually those that did the work will insist that the plans were followed closely. If possible, an effort will be made to make it appear that the public smoke inspector was at fault, either because of advice he may have given or because he permitted poor equipment to be installed. Therefore, the smoke inspctor should follow up all work of construction or alteration and see that it is being done according to the plans.

Carrying on the work of enforcing a smoke ordinance, the smoke inspector meets men who will work hard in an effort to evade complying with the terms of the law. Constant pressure and friendly advice, together with court action, will finally bring them to time. Because, as one owner expressed it: "I can't be fighting you all the time; I must give some attention to my business. Now what do you want?" In other words, these men fix up in order to be rid of the smoke inspector and prevent his buzzing around like an annoying mosquito that one cannot destroy. At such times the inspector must be very careful, as any slight mistake he may make will be magnified many times. Above all, he should be very cautious about urging possible economies, as a reason why certain things should be done in order to stop smoke. Failure to realize the savings will be used in an attempt to show the inspector incompetent, when, as a matter of fact, economies depend mostly upon skillful operation and the inspector has but little influence and no check upon the operation.

Scores of devices, promoted as "smoke consumers," can be placed in the general class of steam jets. Promoters of equipment of this character will make glowing claims of the blessings their devices have been to plant owners, usually located in other cities, and how they will be able to stop the worst smoker in town without making any change to the present equipment. Careful investigation will show that the facts seldom bear out the claims. It has been known where promoters of this kind were positively proven to be in error have publicly stated that they were being persecuted, that the evidence produced was fraudulent, and besides that the witnesses from other cities had lied, as the promoter had contracts aggregating $200,000 in those cities.

Difficulty is always experienced in dealing with promoters of "smoke consumers," as but few of them appreciate the limitations of their devices. In cities where the smoke ordinances require the issuing of permits before work is started upon furnace installations or extensive alterations, it is customary to treat the "smoke consumer" the same as the plain steam or air jet that the plant engineer may install for $10.00 and labor. That is, the devices are considered not to be adequate provision for the prevention of smoke. Cities that have most carefully studied this phase of enforcing smoke ordinances do not issue permits for equipment that cannot operate with an average smoke density of less than 5%. The average smoke density for most so-called "smoke consumers" is from 9% to 14%. That is, their average performance is such that the smoke produced is two or three times as much as satisfactory equipment will emit.

It has been suggested that smoke departments be required to furnish blue prints and specifications for furnace installations. At first, this may appear as a good idea. But thoughtful consideration will show that it is not advisable. Undoubtedly there are many of the smaller plants that need the assistance of the public smoke inspector who is a trained engineer. On the other hand, the larger plants are well able to take care of themselves. Therefore, it is better to leave it optional with the smoke inspector as to whom he provides with plans.

Present practice in cities that have engineering bureaus for enforcing smoke ordinances show a strong tendency to follow the lead of such bureaus, especially so in the design of hand-fired furnaces. This practice does not foster the development of individual thought. If it were compulsory for the smoke inspector to supply plans and specifications, there would be even less incentive for the individual. Besides, furnace users could request plans, install a furnace, give but little attention to operation and charge the poor results to the design for which they would disclaim any responsibility. Some cities have engineering staffs that advise with plant owners on questions of furnace design and operations, but the responsibility for the selection of the equipment is placed upon the owner. In one of these cities it was found that 32% of all the stacks reported as violating, during a year, had modern equipment where violations of the smoke ordinance were due to gross carelessness in operation.

Problems requiring solution in the work of smoke abatement have not all been solved by any one community. Certain sections have been more successful in a given line than other localities. The smoke inspector of one city will hear of results being had at some other place which he believes would be beneficial if they could be obtained in his own town. The best information upon matters of this kind is to be had only upon personal investigation. For example, billet heating furnaces or malleable iron annealing ovens may be a source of annoyance in some city. Investigation by the smoke inspector of what is being done with powdered coal, producer gas, underfeed stokers, etc., will show him what can be done that will be commercially profitable and improve smoke conditions of his city. He will then be in a better position to enforce the smoke ordinance in like cases. It also may develop that the original information was misleading and the results of which glowing accounts were received are not satisfactory, or that the apparatus used is not adaptable to the condition in mind.

One very good way of learning what is going on in different parts of the country is to attend the annual conventions of the International Association for the Prevention of Smoke, where one can meet the leading smoke inspectors and other authorities on furnace work. By personal conversation with these men one can learn more definitely than by correspondence or hearsay the methods used and problems met in their home cities.

Most citizens have but a vague idea of how city ordinances or other laws are enforced. Probably the smoke regulation laws are as little understood as any statutes on the books. Whenever complaints are made by citizens of smoking chimneys, smoke departments should take advantage of these opportunities to explain to the parties the provisions of the law, its limitations and methods used to enforce it, together with other features that need be taken into consideration. Complaints from local Improvement Clubs or other associations should be acknowledged with an offer to have some one call upon them to explain the work being done by the smoke inspector; give them some idea of the magnitude of the work, benefits to be derived, the force that is available and other points they should know.

Records showing how much has been done in efforts to abate smoke are of value in publicity work. Data of the approximate cost of making alterations and improvements should be kept, together with information as to the benefits resulting. Statistics of this character will show, both the owners and the public, that enforcement of a smoke ordinance, along constructive lines, is a benefit to all affected. There are a few parties who always hedge because they never can see any benefit to be had from spending money in order to comply with the terms of a law. Even with these records and cost are of assistance for they can console themselves that others are spending money for similar purposes; and misery loves to have company.

The basic idea in any program for the enforcement of a smoke ordinance should be a general campaign of education in which every effort is made to develop the feeling among firemen, engineers and others, that it is as important to keep the smoke down as to keep the steam pressure up. After this way of thinking has become so general that a man applying for the first time for a job as a fireman will be imbued with that idea, the duties of the smoke inspector will be very easy compared with the present day.

More or less unconsciously manufacturers regulate their business so as to inconvenience or offend the public to the least degree. The private citizens of a community can help by letting the owners of the smoking chimneys know that they, the citizens of that neighborhood, object to the smoke by notifying the owners direct and also giving the smoke inspector definite information as to the time and kind of smoke produced. Many citizens think all that is necessary is to make a complaint to the smoke inspector's office—this helps to a certain extent, but not as much as if the citizen also makes known to the owner direct that he objects to the way the owner is permitting his stack to smoke. Many plant owners tell the smoke inspector that no one in the neighborhood is complaining, that the smoke inspector himself is the only one who is finding fault, and that he, the smoke inspector, is doing so merely to be officious and make trouble.

If the owners of smoking chimneys were to believe that practically all the citizens of the city really desired and insisted that chimneys be operated clean, it could be done and would be done, but the average plant owner believes there are but few people in the city that care whether or not their stacks smoke.

Lacking a general and strong expression from the public to help him in the enforcement of a smoke ordinance, the public smoke inspector must avail himself of every means to create and promote a rivalry among owners and their employes so that each will try to do better than his neighbors. Certain cities have used average smoke density figures to show the relative amount of light that smoke from a stack prevents from crossing the top of the stack, and comparing these figures with others, showing a better performance with similar equipment and working conditions. The schemes used are numerous, the purpose of all is to get offenders to trying to do better.

In cities where smoke ordinances are enforced most firemen think their stacks are watched constantly when, as a matter of fact, the stacks may be watched comparatively few hours during a month. The fireman watching the smoke from his stack wonders if the inspector will complain about it, for he is sure that official is also looking at the same smoke. If he hears nothing from the inspector, he is certain that the smoke was not bad and does not try to do better. Finally he is called to account for a performance which he knows was better than on many other occasions. These experiences lead the firemen, and even other persons, to think the smoke inspector is inconsistent. Therefore, any plan that will cause operators to endeavor to do better than their neighbors will lead to more beneficial results than merely an effort to avoid the criticism of the public officer.

Smoke departments should keep their records of observations or watchings of chimneys in such form as to show the usual performance of a stack. That is, if a stack violates occasionally, but runs clean a large part of the time, the records should show those conditions, so that when the owner is summoned to the smoke inspector's office he can see he has been given credit for the good performance as well as the bad.

When working with a plant in an effort to stop their smoke, consideration should be given the plant engineer. Often, if allowed freedom of action, he will be able to so improve the smoke performance that outside help is not required. The public smoke inspectors should co-operate with the men in the plants, making suggestions and telling them of experiences had in other places. After arousing their interest and getting them to working on their problems, care should be taken to see they are given credit for the improvement, even though the ideas may have been the smoke inspector's. Credit for a general improvement on the part of many plants will be given to the smoke inspector.

It is important that uniformity of treatment be given all owners of smoking stacks. They may feel at times that the enforcement of the law is a little harsh, but they will seldom complain if they believe that all others are being treated in the same way; especially so if they are satisfied that the smoke inspector is trying to be fair to all parties and wants to co-operate with them. Should an owner think that favoritism was being shown to some of his neighbors, he will spend more effort to avoid complying with the law and in attempts to gain immunity from prosecution than he will spend to reduce his smoke. Every smoke inspector has had some one say to him: "That's all right, I don't want any special consideration, but I do want as much as the other fellow gets."

Manufacturers and their managers are thoughtful, well-intending men, who have enough experience with human nature to know that there are many people going about the world advising other folks what to do that really know but little about the subject upon which they give advice. When the smoke inspector is asked with great sarcasm, "Do you think you know more about my boilers than the manufacturers of them?" he must be patient and find some way to reason with his man in order to get him to study the matter closely for himself. Bombastic or dictatorial methods will never gain as permanent, desirable results as careful answers to all questions.

Enforcement of a smoke ordinance should be followed up with consistent regularity. It is natural that the owners and operators will inquire among their friends and acquaintances for suggestions of how to deal with the smoke inspector. Some of the advice received will be: See this or that politician; buy coal or other material used from a given party, and more information of like character. Possibly some of these hints might be acted upon, and at the same time the smoke inspector, unwittingly, transfers his attention to some other plant or distant section of the city and does not give the case any further attention for several weeks or months. Parties who took indirect action with a view of having the smoke inspector "let up on them" are certain they have found an effective way of pacifying the demands of that officer and will repeatedly tell of their experience. An inspector that conducts himself in an officious manner with much bluster and ado, and who neglects to properly follow up every case he starts upon, need not be surprised if an impression gets more or less established that he is dishonest.

When watching stacks in order to apprehend possible violators, one must avoid the rut of routine. Firemen will quickly learn if they are caught violating only at certain hours or upon given days that those are the times to be particularly careful, and that at other times it does not make any difference.

Speaking of the rut of routine, the smoke inspector is to be pardoned when he feels that all parties offering excuses or reasons for violations of the smoke ordinance are traveling in the same rut. There is but little variety in the explanations received. At times the inspector thinks he will try to get out a set of printed forms so as to save his friends trouble of dictating and himself of reading the same stories over and over again.

Owners should always be given a fair warning before suit is started or arrest is made, of the action they may expect if their stacks continue to violate. Warning may take the form of several letters and personal visits. The records should show that everything possible was done to get results before court action was resorted to. This course protects the inspector from criticism of undue zeal and places the offender in the position of disregarding the will of the public as expressed in the law.

When first starting the enforcement of a smoke ordinance, it is advisable to send letters to the parties responsible for a stack that violates, inviting them to call at the office of the smoke inspector and explain the reason for the offense and discuss ways of remedying the evil. After two or three years, that is, after all plants have been given ample opportunity to get in shape to comply with the law, a policy of taking court action when a given number of violations are observed upon the same stack or upon the same plant in a given number of days will effect surprising results in smoke reduction if the policy is stiff enough. Four or five of the larger cities have adopted policies of this kind. Possibly the most stringent is the one followed by the Chicago Smoke Department. In that city smoke violators are not subject to arrest or injunction proceedings. The city institutes civil suit in the Municipal court against the responsible party following the same procedure as if the case were one to collect damages.

The policy followed by the Chicago Department, in dealing with violators of the smoke ordinance, is known as the "Thirty-Day Rule." Under this rule two violations observed upon a sationary plant or marine craft during thirty consecutive days constitute sufficient cause for suit. When a violation of the ordinance is observed, a letter is sent to the responsible party warning him that another violation within thirty days will result in suit. Should a second violation occur within the time specified, the evidence of both violations is sent to the Prosecuting Attorney and a letter sent to the plant owner informing him that suit has been instituted. The exceptions to the rule are violations reported upon plants that are actually engaged in alterations or additions, that make working conditions so difficult that it is unreasonable to expect proper operation all the time or violations due to some accident that proper precaution could not guard against.

This stringent policy was adopted by the city after the Smoke Department had labored incessantly for several years with the plant owners in an effort to clean up their stacks. It was found that after this lapse of time the constant smokers remaining needed to be handled with a stronger hand.

The suit policy against railroads operating in Chicago is similar to that applied to stationary plants and has been developed from data compiled from a number of years' experience which indicate the relative opportunity the Smoke Department has of seeing locomotive stacks, due—

First: To the number of engines operated in the city by the railroad.

Second: To the location of the railroads.

Third: To the opportunity of observing locomotive stacks as compared with the opportunity of observing the average stationary stack.

Taking these factors into consideration, a schedule was worked out which allows a varying number of violations per month to the different railroads. If a railroad is observed violating in excess of the number allotted to that road, suit is started upon the evidence of all violations reported for that month.

The accompanying curve, figure 2, is interesting as it shows the relative number of violations observed upon stationary plants per hour of watching for fifteen months before the thirty-day rule went into effect (January 1, 1914) in the territory from which the data was gathered, as well as for sixteen months since then. The curve shows a sharp dropping off in the number of violations observed after the enforcement of the thirty-day rule.

The curve from October, 1912, to December, 1913, is typical of the previous years, and is given to show how the rate of violating the smoke ordinance varied at different seasons of the year before there was a strict rule enforced that compelled careful attention to be given to furnace operation at all times.

Note that the curve for October, November and December, 1913, conforms closely to the shape of the curve for the same months in 1912. Following the enforcement of the thirty-day rule, in January, 1914, the curve drops instead of continuing to follow the same shape as the year previous. There is a marked difference in the height and in the shape of the curve for October, 1914, to April, 1915, as compared with October, 1912, to April, 1913. The curve for October, 1914, to April, 1915, is repeated (in dotted line) on the ordinants, October, 1912, to April, 1913. The vertical distance between the dotted and solid line curves, for these ordinants, shows clearly the improvement brought about by the enforcement of the thirty-day policy of instituting suits for violations of the Chicago smoke ordinance. If no violations were observed, the curve would drop to the base line.

Owners and employers, as a class, are more responsible than their employes. Owners will take a more active interest in their plants when they know that they will be held responsible for the smoke performance of those plants, and that they will be called upon to spend their time, if conditions are not satisfactory, in making explanations to the Smoke Inspector and to the Court. The company or firm paying the wages of the fireman and engineer should be considered the responsible party. By holding these people responsible for all violations, the smoke inspector can avoid discussion as to whether or not the plant equipment is in first-class condition. If an employe does not have the ability to perform the duties expected of him without violating the smoke ordinance, even though good equipment is furnished, it is up to the employer to get better help even though more money may have to be paid.

Most smoke ordinances are so worded that court action can be taken against the fireman, engineer, superintendent, manager, lessee or owner. Cases are rare where it is justifiable to take action against any one but the management of the company operating the stack. If the ordinance definitely states that the engineer or fireman shall be held responsible, the ordinance should be changed.

Building ordinances, electrical ordinances, fire prevention ordinances and similar laws give in greater or less detail a description of construction that may be used as a minimum requirement. They further give definitions, rules, formulas, etc., by means of which calculations can be made to determine the requirements for any case.

The average smoke ordinance in vogue in American cities today places in the hands of one man dictatorial powers as to what, in his judgment, is, or is not, sufficient equipment or adequate provision for the prevention of smoke. In the wording of these ordinances, the smoke inspector is, supposedly, given the authority to refuse a permit for apparatus that does not meet with his approval.

There are strong grounds for the contention that the smoke inspector has not, under an ordinance which does not specify minimum requirements, the right to refuse to issue a permit for the installation of any apparatus for which an application is made. In other words, the claim is set up that the smoke inspector has no more legal authority to refuse to issue a permit for a furnace installation than the city collector has to refuse to issue a permit or license to keep a dog when the legal fee is tendered him.

Many promoters of so-called "smoke consumers" go to the office of the smoke inspector for permits to install their apparatus in some plant where they have prospects of making a sale. Often these sales hinge on the point of whether or not the smoke inspector will issue a permit because the owners and managers of the small steam plants depend upon the modern smoke inspector to protect them from the wiles of the insidious and the schemes of the irresponsible.

The following is a brief outline of a policy that can be adopted in dealing with promoters of apparatus or equipment that has not sufficient merit to morally justify the smoke inspector in issuing a permit which will be accepted by the layman as the smoke inspector's personal judgment and recommendation of the merits of the device.

In the ordinary course of business of a department, the architect, contractor or furnace company can be allowed to act as the agent of the owner and permits can be issued to these parties as an accommodation to the owner. If an application is made for a permit for the installation of apparatus, which, in the judgment of the smoke inspector is not ample provision for the prevention of smoke when operated by the average fireman, the department can refuse to recognize any one but the owner of the plant and can require him to appear in person and sign the application for the permit.

By handling applications for permits to install apparatus of doubtful merit in the above manner, legal entanglements can be avoided and promoters can be prevented from getting any advantage that might be derived from a court decree ordering the smoke inspector to issue permits for a given device.

Salesmen of devices for the prevention of smoke will call upon the smoke inspector to learn what attitude he will take with regard to their apparatus. A very clever way to handle these people is to welcome them with open arms, telling them there is much need for everything that will reduce the smoke. They can be told that they will be expected to operate with less than 5% density under normal operating conditions and that they must do 2% or less under test conditions. The density to be determined for a period of hours as described in the supplementary report of the Standardization Committee of the International Association for the Prevention of Smoke, submitted to that Association, September 8, 1915.

Negative results at times are as beneficial as positive success. An owner, who insists contrary to suggestions of the smoke inspector, upon putting in equipment that experience has proven will be a failure, may think that he is putting something over. As a matter of fact, he is helping to strengthen the inspector, who will have an example he can point to and say, "I told him so."

While on the subject, it may be well to remind the smoke inspectors that in their efforts to stand straight and be neutral in advising with owners relative to equipment for their plants, that it is possible they may actually lean backward. If there is some particular type of equipment that is the best adapted for a given condition, a smoke inspector should have no fear in suggesting its use.

The small plant needs the advice of expert engineers, trained in boiler room practice, that know how to build and operate furnaces, so as to get economy and clean stacks. The smoke inspector has an opportunity that but few other men get of studying the advantages and weaknesses of all manner of fuel-burning apparatus, smoke abatement devices and methods of operation. The inspector who has past experience as an operating steam engineer, who is energetic and studious, will in a few years develop into an expert whose advice is of value to both the small and large plant, and also to the city, because of his ability to definitely determine the value of the various claims made concerning the obstacles hindering a full compliance with the smoke ordinance.

A smoke department should interpret its responsibility broadly; it should endeavor to co-operate with the owners of fuel consuming plants by intelligent study of their problems; it should be reasonable in its requirements and should resort to legal processes only when lack of proper support demands recourse to the law.

The personal element enters into the operation of every furnace to such an extent that it must be taken into consideration. Although furnaces may be mechanically fired, all of them, such as the front inclined stokers, side inclined stokers, underfeed stokers and chain grates, depend to a great extent upon the attention given them as to whether or not the stack is clean and the plant economical. It is the personal element that must be taken into consideration in all discussions of the smoke problem. The ultimate practical solution of the problem is the education of the operating men, and a realization, on the part of the owners, that the fuel-burning equipment is an important feature of their shops, not a necessary evil to be shunned.

DISCUSSION.

EXPLANATION OF THE CURVES.

Fig. 1 shows graphically the increase in population in Chicago since 1866 and also gives the coal consumption since that year. The solid line of the coal curve is from statistics compiled by the Chicago Board of Trade. Corresponding figures were not kept after 1902. The dotted line on the coal curve shows the average coal consumption during the years that data were kept and a projection of that curve.

The curves "population" and "coal consumption" bring out very forcibly how the use of coal in our manufacturing cities has increased more rapidly than the population. In 1866 the coal consumption was 2.3 tons per capita. In 1888, the point to the right of the coal consumption arrow, the rate was 5.6 tons per capita and in 1902 it was 4.6 tons. The solid line of the coal consumption curve shows an increase of 100% in eight years, 1894 to 1902.

The Committee of Smoke Abatement and Electrification of Railway Terminals of the Chicago Association of Commerce has, since 1911, been making, at the expense of several hundred thousands of dollars, a very exhaustive investigation of the smoke conditions in that city. During

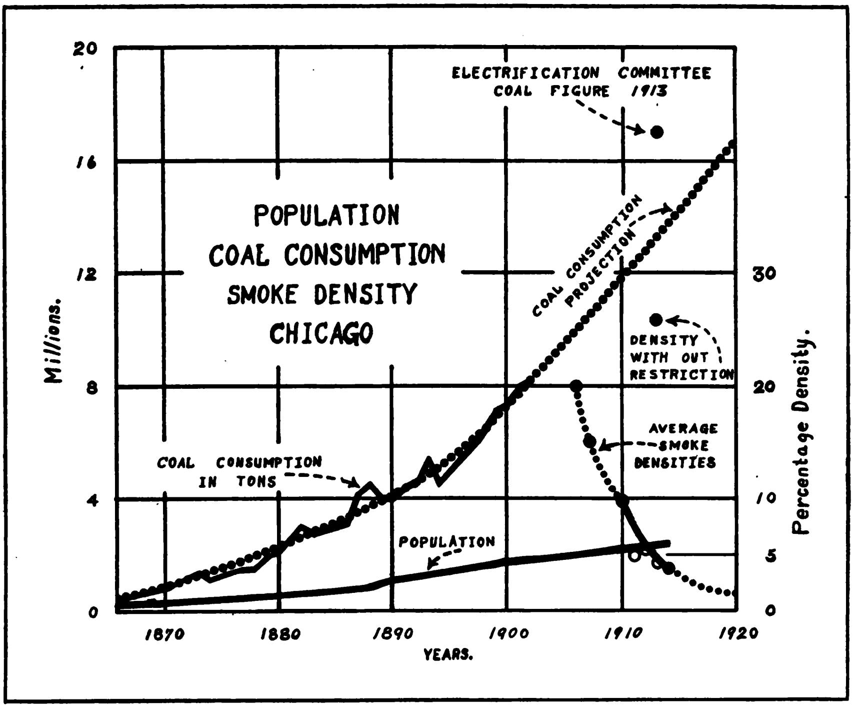


Figure 1

1912 and 1913 they carefully determined the coal used in their city and announced the figure at seventeen millions of tons per annum. This figure is shown in the upper right-hand corner of the chart and is a rate of 7.25 tons per capita.

As the coal consumption increased the volume of gases produced by the burning coal increased. During the past few years the color or density of those gases has decreased to a remarkable extent, due to the constructive work of the city smoke department.

The curve "average smoke densities" shows how the color of those gases has decreased since 1906. The two rings around spots in the upper dotted section of this curve locate points that were estimated during the years 1907 to 1910. The solid section of the line represents conditions found from statistical investigation during 1910 to 1914, by the city smoke department. The lower dotted section of the curve shows the improvement that can be expected if the past policy of enforcing the smoke ordinance is followed.

The point, "Density without restriction," represents the color of the chimney gases in cities immediately surrounding Chicago that are without

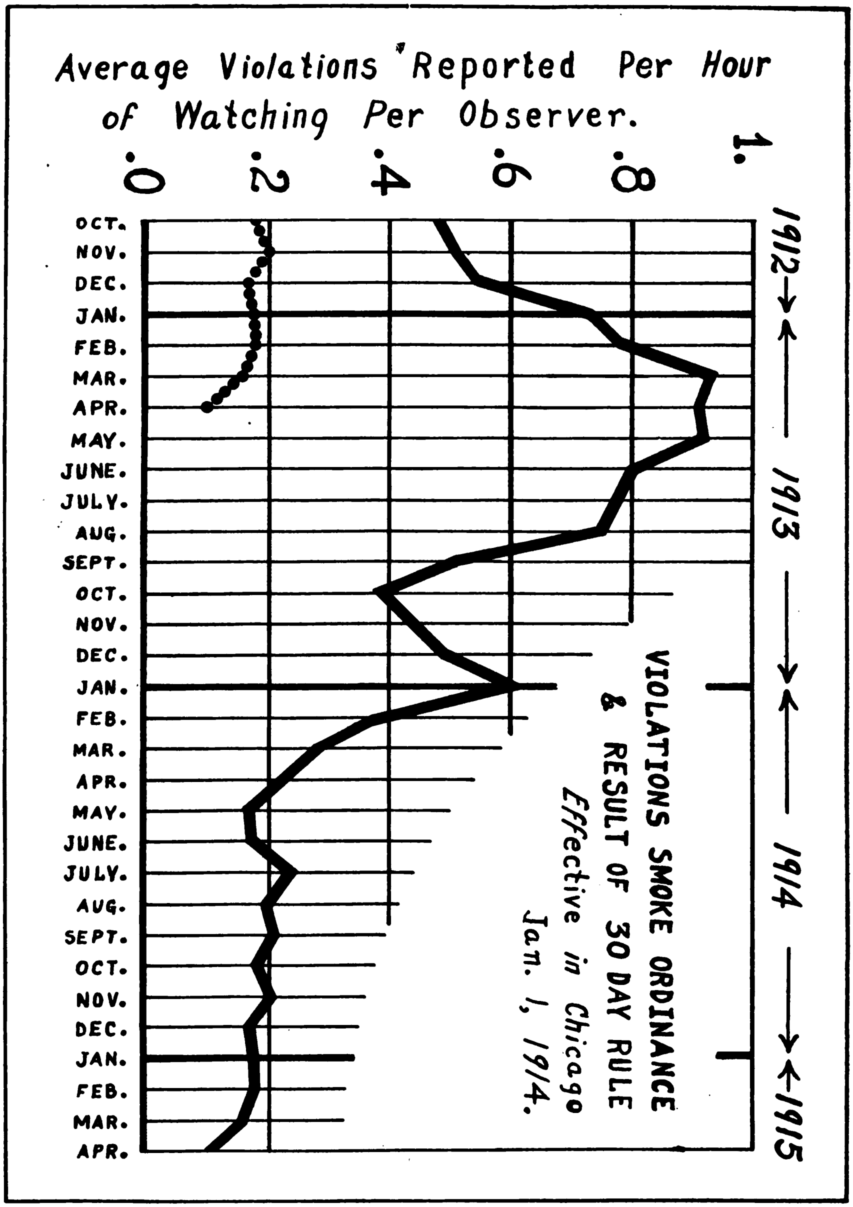


Figure 2

smoke regulation. A comparison of this point with the smoke density in Chicago for 1914 shows that the smoke emitted by chimneys in cities without smoke ordinances was on the average 7⅔ times as dark as in

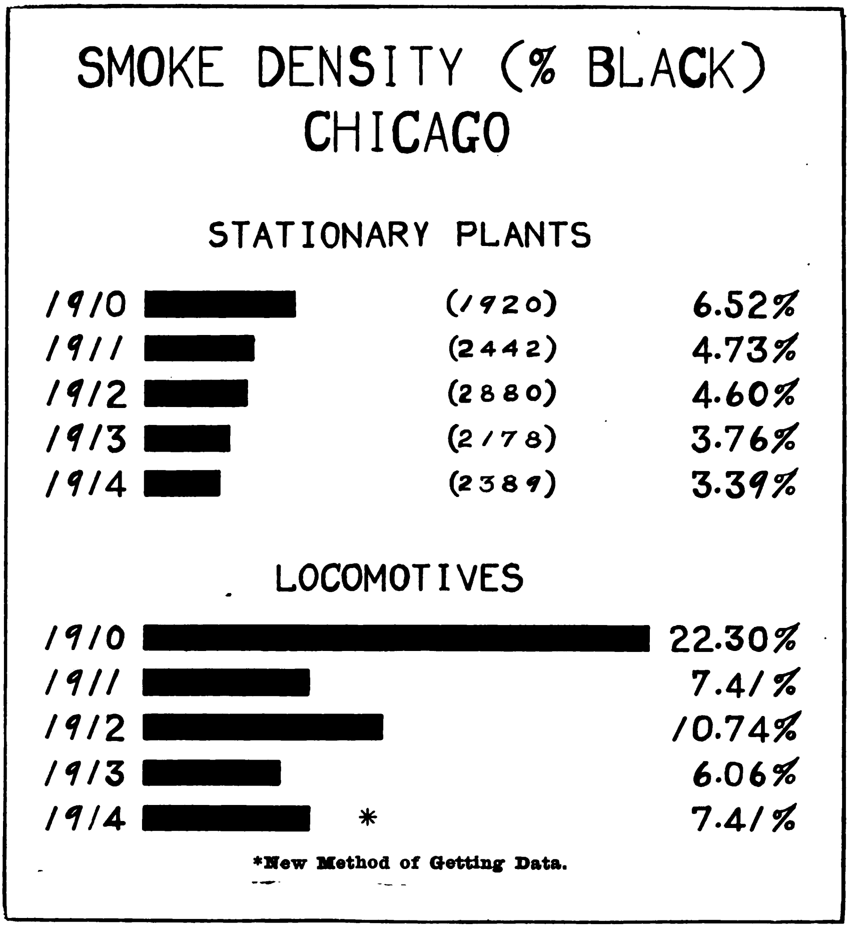


Figure 3

Chicago. That is the average chimney referred to outside of Chicago prevented more than seven times as much light from crossing its top as did the average chimney in Chicago.

Fig. 2. Dividing the number of violations of the Chicago smoke ordinance reported per month upon stationary plants by the aggregate number of hours the stack observers spent watching stacks, gives the average violations reported per hour. For the territory to which the curve refers, a rule was established January, 1914, to the effect that if two violations were reported upon the same plant within thirty days of one another suit was thereby automatically started. The curve shows clearly the decrease in the number of violations of the smoke ordinance after January, 1914, due to the enforcement of this thirty-day rule. The

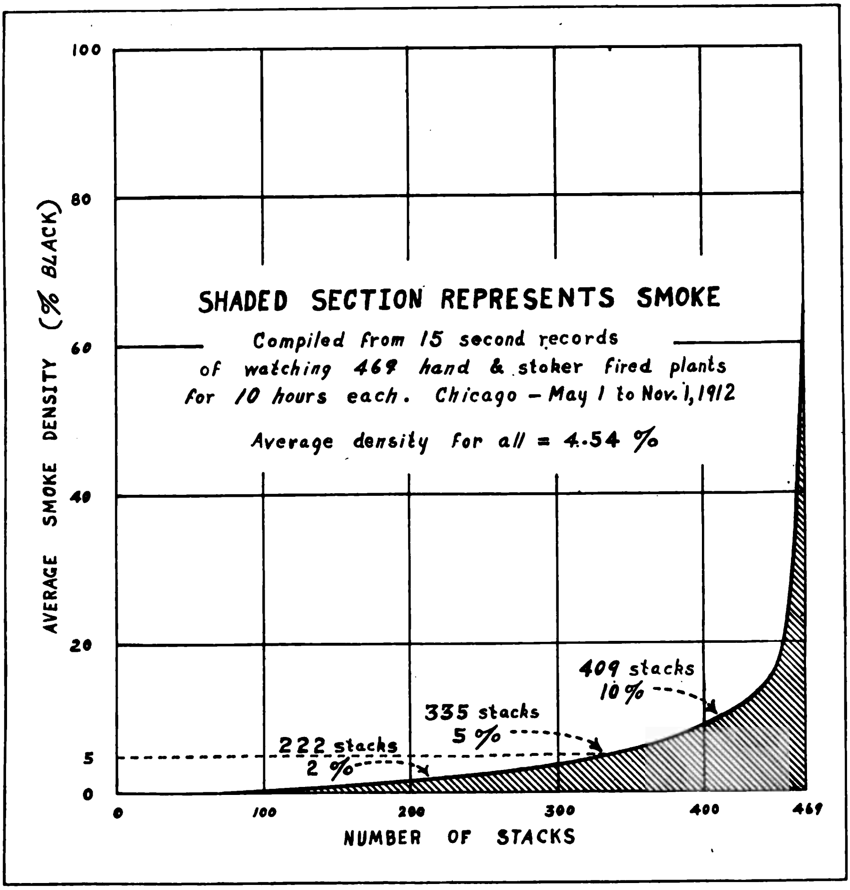


Figure 4

curve for the months October, 1914, to April, 1915, is repeated in dotted line on the ordinates for 1912 and 1913. The vertical difference between the solid and dotted lines shows a decrease of 60 to 90 per cent in the violations reported. For further information about the curve, see the discussion presented in the main body of the paper.

Fig. 3. In 1912 the Chicago Smoke Department established for their guidance a standard for determining whether or not a chimney was making a satisfactory performance of smoke abatement. The standard was arrived at after watching 469 stacks for an aggregate of ten hours each and making a record, every 15 seconds, of the color or density of the smoke proceeding from the stacks. From these data figures were calculated known as percentage density. Two per cent density for a chimney means that during the observation, 2 per cent of all the light that

would have crossed the top of the stack to the observer's eye was prevented from doing so on account of the smoke.

The stacks selected for these special observations were chosen by classes of industry and not on account of furnace equipment, load or methods of operation. That is, representative factories, office buildings, hotels, department stores, clubs, breweries, packing houses, etc., were chosen. The figures of average density were arranged in the order of their size and are shown on the curve. The densities ranged from 58 stacks with no smoke to one with a density of 65.4 per cent. The average for the group was 4.54 per cent.

The smoke department then told the promoters of furnaces and so-called "smoke consumers" that a performance of 5 per cent density under normal operating conditions would be considered satisfactory.

The curve shows that 335 or 71.5 per cent of the 469 stacks did 5 per cent density or less.

Most devices promoted as "smoke consumers" will average from 9 per cent to 14 per cent density. (See Fig. 4.)

Fig. 3 is the average percentage density for stationary plants and for locomotives in Chicago for the years given. The figures show the improvement that has been made in smoke conditions in that city. They further show that the standard of 5 per cent density for satisfactory performance is reasonable because for four years the average density for all stationary plants was less than 5 per cent.

The figures for stationary plants were gathered by watching the number of plants given in the parenthesis for two hours each and recording each half minute the color of the smoke.

Promoters of equipment that cannot do 5 per cent density argue that the standard should be 10 per cent or 15 per cent density. The density figures for locomotives show that a 10 per cent density is too high for stationary plants. It is far more difficult to obtain smokeless operation of a locomotive using high volatile coal than it is with a stationary plant. For three years the locomotives of Chicago did less than 10 per cent density.

S. H. Viall, Secretary, Chicago, Ill.: Now, gentlemen, I have three or four slides that will show you very graphically and very briefly some of the things that were gone over in the last half of the paper; so we will put on those slides and show why the smoke problem is getting to be a big problem in our cities and what results have been had from a given scheme of handling the question. (Showing slides.)

President Towner: Has any one any question that he would like to ask Mr. Viall?

J. H. Lewis, C., B. & Q. R. R., Chicago, Ill.: I would like to ask one question of Mr. Viall: Have you got any data showing the number of locomotives observed at that time, Mr. Viall?

S. H. Viall, Secretary, Chicago, Ill.: I have not. I did not bring the figures of locomotive minutes because I did not think that it would be intelligible as giving the number of facts. Our data was kept in such a way that we did not pick out individual locomotives. The data on locomotives for each one of the lines represented about 25,000 minutes.

President Towner: I would like to say for the benefit of the gentlemen who are leaving the room that you are going to miss an awfully good paper if you go away at this time, because the next paper is an excellent one; it is on Boiler Room Practice. Now, if there is nothing further, we will take up the next paper, which is an illustrated lecture, entitled "The Effect of Furnace Design on Fuel Economy and Smoke Abatement in High and Low Pressure Work," by Mr. O. Monnett of Chicago, Ill. (Applause.)

THE EFFECT OF FURNACE DESIGN ON FUEL ECONOMY AND SMOKE ABATEMENT IN HIGH AND LOW PRESSURE WORK.

PAPER BY O. MONNETT, CHICAGO, ILL.

Mr. President and Gentlemen:

We frequently hear of the great saving that is being made by the suppression of smoke, but it is very seldom that we get definite figures on these savings. I believe that dollars speak louder than words, and if we can get some definite quotations along this line, they would be of value in the smoke movement.

Now, it is not my purpose tonight to give a complete treatise on the science of furnace designs for smokeless operation, but I will make a few selections showing typical savings by the suppression of smoke.

Authorities all agree that there is very little combustible matter in the smoke itself; probably one or two per cent of the fuel value is represented in the smoke; so that suppressing the smoke and saving one or two per cent would hardly be an item in the proposition; but my illustrations tonight have been selected for the purpose of showing what other factors come into the proposition when we save through suppressing smoke. Each case that I have to present will show a different combination of circumstances under which saving was made which was due to other factors aside from direct smoke elimination.

CASE I.

This was the case of three return tubular boilers using a furnace that was being used in Chicago about six or seven years ago, known as the Firebrick Enclosed Dutch Oven, flush front. The disadvantages of this furnace are that it insulates a large portion of the surface of the boiler and imposes a heavy duty on the fire in maintaining a large quantity of brick work at an intense heat. This furnace was taken out and a more modern furnace put in, which exposed the heating surface direct to the fire, and gave a high temperature zone over the bridge wall, the combustion being complete before the gases came into contact with the boiler surface. Before the alterations were made the plant used twenty tons of coal in twenty-four hours at $3.25 a ton, making $65.00 a day fuel expense. After the changes were made, the plant was operated on fifteen tons of coal at $2.25 per ton, or a total of $33.75; making a saving of $31.25 a day, or practically fifty per cent. Thus the alteration of the furnace design increased the heat absorption and enabled the burning of cheaper coal to carry the load.

In this case, as stated, the shell of the boiler was insulated from the hot gases, and in the second place the insulation not only decreased the capacity of the boiler, but decreased the economy, and it also imposed on the fire the additional responsibility of keeping this brick work hot; but the great disadvantage of the smoke inspector's standpoint of that setting was the unsatisfactory smoke performance. This type of setting brings up the whole proposition of hand fire furnace design, and I have selected it for that reason. When we throw green coal on the fire, the heat underneath commences to distill the volatile matter from the coal. The volatile matter, as we all know, is what makes smoke; but in a Dutch oven of this kind, with the red hot brick above the fire, there is a secondary action when the intense radiation from the hot firebrick strikes the top of the fuel bed, creating secondary distillation of volatile matter which aggravates the smoke performance of the stack, making this setting entirely unsatisfactory from the smoke standpoint.

CASE II.

This was another case of the Dutch oven class of furnace; a full extension furnace, which had some additional disadvantages which were not apparent in the first installation. In the first place, a full extension furnace takes up more floor space, and in the second place, the intense radiation from such a furnace is a direct loss in fuel economy. In this particular instance there were four return tubular boilers in the plant operating twenty-four hours a day. The Dutch ovens were replaced by flush front double arch bridgewall setting, the fire directly under the boiler radiating direct to the heating surface. The saving in coal was one hundred tons a month at $3.00 a ton, making a total saving of $300.00 a month. In this case there was no change in the character of fuel supplied.

CASE III.

This was the case of a typical No. 6, or double arch bridge wall setting as developed by the Chicago Smoke Department. This is a "cool" furnace, or direct radiating furnace such as I spoke of in the other instance. The heat of the fire is exposed directly to the shell, increasing the heat absorption, and further on behind the brick wall is the high temperature zone, which in this case is in a two-span butterfly arch with pier on the center, and a deflection arch in one span behind the high temperature zone against which the gases impinge completing combustion.

The plant was a railroad roundhouse operating six boilers twenty-four hours a day, where the boiler settings were in very poor condition. Live steam was used in the stacks to create draft. After the stacks had been rebuilt, the leaks had been stopped up in the settings and double arch bridge wall furnace installed, there was a total saving of $800.00 a month in full, with no change in the size of the fuel used.

CASE IV.

This was a typical Hawley down-draft installation with return tubular boilers. On a down-draft installation with a rate of combustion approximately 25 lbs. coal per sq. ft. grate surface per hour, it is necessary to work the fire quite frequently in order to keep up steam. A peculiarity of the down-draft is that the oftener you work it, the more chance you have of making smoke. On a high pressure power installation it has been found to be very advisable to put some type of brickwork construction behind the bridge wall to catch any excess of volatile matter and mix it with the air which should be admitted on the bottom grate during the process of slicing the fire.

Originally there were four boilers on the line to carry the load. The plant was in continual trouble due to violations of the smoke ordinance and in court all the time. The trouble with the equipment was that they were trying to burn too much coal and they were allowing some volatile matter to pass off, making smoke. With a deflection arch and air admission on the lower doors it was found possible to carry the load with three boilers, saving the radiation losses on that boiler and saving $1,500.00 a year in the fuel bill.

Another similar case was one in which four boilers were used with the same type of equipment; the alterations consisted of putting in deflection arches behind the bridge wall, air admission in the doors, 35 feet extension on the stack and a smoke indicator. The figures for this plant after the changes were made showed a saving of 3 tons of coal per day at $2.65 per ton, making a total daily saving of $7.95, or between $2,500.00 and $3,000.00 a year.

CASE V.

This was a case of a battery of three Heine type boilers burning No. 5 washed coal, which they were using primarily because of smoke trouble. If they got the No. 5 washed coal they could carry the load and stay inside of the smoke ordinance; but in 1912 the coal strike came along and they had to use No. 4 wash coal, which makes a little more smoke on account of the more liberal admission of the heat to the fire, and they found that they could not carry the load and stay inside of the smoke ordinance. Alterations were made in the setting as follows: The box tile were taken off from the front over the fire for a distance of 4 ft. 10 in., admitting the heat of the fire direct to the heating surface. This, of course, increased the steaming capacity of the boilers. A three-span deflection arch was put in so as to break up the current of volatile gases. Air admission was provided in the firing doors and the grate surface was shortened and widened so that there was the same amount of grate surface as before, but it is much easier to handle a wide, shallow grate than it is to handle a narrow long grate.

After the changes were made it was found that the total saving was $3,800.00 a year, which saving was principally due to the fact that they could carry the load on one boiler, whereas they formerly carried one banked fire all the time in order to take care of two hours of peak load at night. Cutting out of this idle boiler was the greatest item in the fuel saving.

CASE VI.

This was a case where smoke trouble was not of the first importance. It was a chain-grate plant with a battery of eight horizontal water tube boilers. It was impossible to carry the load on the eight boilers. The original installation consisted of a very low ignition arch both in front and back, with restricted openings for the first gas pass. The speed of the chain-grate was 11½ inches per minute. The alterations consisted in raising the arches to 15 inches at the gate and slackening the speed of the grates to 3½ or 4 inches per minute, also opening up the first baffle. The arches were also raised to 21 inches at the back, making a practically level arch with an inclined stoker, giving better ignition and greater capacity for burning coal. After these changes were made the plant operated with a saving of eight hundred tons of coal per month, at $1.50 per ton, amounting to $1,200 a month, while the load was carried easily.

CASE VII.

This was a case where down-draft principle was employed to cure such trouble and making a saving. The advantages of the down-draft principle for heating loads can be realized when it is remembered that the frequency with which the coal is distributed is a great factor in the amount of smoke made. Therefore, the longer the fire is left above, the less smoke is made. The fire rests directly on the heating surface and the volatile matter is being distilled and passing through the high temperature zone. In this way the coal becomes coked and the volatile matter is gradually distilled off.

In a heating job, the coal lays on the fire for a long period and accumulates a thick layer of coked coal over the heating or water element. When the fire is sliced, this layer of incandescent fuel is worked down to the bottom of grate. The secret of success with a heating load is to fire heavily and not to disturb the fire except at long intervals—the longer the better. In the case under discussion, the plant burned seventy-five tons of Pocahontas coal, at $4.50 a ton, with a plain-grate boiler, at a total cost of $337.50; after the change was made, the plant operated on seventy tons of coal, at $3.25 per ton, or a total of $227.50, or a saving of $110.00 per season.

DISCUSSION.

President Towner: Has anybody any questions that he would like to ask at this time?

Charles W. Heath, Chf. City Smoke Insp., Cincinnati, Ohio: I have been very busy during the evening and have not had a chance to get inside here; but I want to ask Mr. Monnett whether in every case where there has been a reduction of smoke there has not also been a certain amount of fuel saving where the matter was handled properly?

O. Monnett, Smoke Insp., Chicago, Ill.: Cases have come to my attention where it was claimed that there was no saving that could be connected with the suppression of smoke. It might be possible that there are some combinations of circumstances that would make that possible, but I would say that in ninety-five per cent of the cases where any reasonable attention has been given to operation that there would be a definite saving in the fuel attendant on the suppression of smoke.

MR. TAYLOR: Where you put in a device like one of those shown there, is it not possible that you would have such an excess of air that you would lose all of your savings?

O. MONNETT, Smoke Insp., Chicago, Ill.: If so, it would be due to the operation. If you got an excess of air all the time, you might have enough excess air to cut down the efficiency of the boiler. The man on the job should give the excess air at the time it is needed while the volatile matter was being cast off, then he would cut down the excess air to a point which would be inappreciable from the standpoint of extra oxygen; in other words, it depends a great deal upon the operation after all. An automatic flap or some type of automatic door operation shows up to great advantage in connection with a properly designed furnace for that reason.

MR. TAYLOR: In those cases where you have changed over your furnace so that a saving was shown, has there been any attempt made to put a draft gauge on the boiler so that the fireman would have something to judge its operation by?

O. MONNETT, Smoke Insp., Chicago, Ill.: No, not very often.

GEORGE W. SNOW, Chf. Smoke Insp., Salt Lake City, Utah: I would like to ask Mr. Monnett how long those arches over the bridge will last and how often do they have to be renewed?

O. MONNETT, Smoke Insp., Chicago, Ill.: A double arch bridge wall burns out about once in eighteen months and costs about $75.00 to replace in ordinary operation.

No further business offering at this time, the Convention now adjourned until 9 a. m., Friday, September 10, 1915.

FIFTH SESSION—FRIDAY MORNING, SEPTEMBER 10, 1915.

The Convention met pursuant to adjournment, President Towner in the Chair.

PRESIDENT TOWNER: We will have as the first order of business this morning the report of the Committee appointed to draft resolutions on the death of Mr. Gerrish.

Mr. Hoffman read the report of the Committee as follows:

RESOLUTIONS IN MEMORY OF WILLIAM H. GERRISH.

Whereas, Since it has pleased Almighty God to remove from our midst our fellow member, William H. Gerrish; and

Whereas, Our departed member was always active and earnest in the welfare of this Association, and his high conduct and integrity was admired and respected by all of his associates, we, therefore, deeply feel his loss; therefore be it

Resolved, That we extend to the wife and family of our fellow member our sincere and heart-felt sympathy in their bereavement, and express the hope that an all-wise and generous Providence will comfort them in their affliction, is our sincere prayer; and be it further

Resolved, That these resolutions be spread in full upon the Minutes of this Association and an engrossed copy be forwarded to the family of the deceased.

(Signed) DANIEL MALONEY,
WILLIAM A. HOFFMAN,
CHARLES POETHKE,
Special Committee.

PRESIDENT TOWNER: The first order of business is a paper on "Smoke Abatement on Lake and River Steamboats," by Roy L. Peck, Chief Engineer of The Great Lakes Dredge & Dock Co., Chicago, Ill.

ROY L. PECK, Chf. Engr., The Great Lakes D. & D. Co., Chicago, Ill.: Gentlemen, I am rather sorry that there are no other representatives of the interests which I represent present at this Convention. Steamboat and river interests seem to have been rather neglected by this Association. You have a large number of railroad men here and quite a good many stationary men, but I happen to be the only representative of the river interests or lake interests. I hope that no one will be disappointed with what I have to say because my paper deals altogether with affairs on lakes and harbors. I have not taken any notice of conditions on your river here, although I am somewhat familiar with them from my past experience. I have not endeavored in this paper to comment at all on river conditions, as you recognize them in this town at any rate.

Mr. Peck then proceeded with his paper as follows:

SMOKE ABATEMENT ON LAKE AND RIVER STEAMBOATS.

BY ROY L. PECK, CHIEF ENGINEER, THE GREAT LAKES DREDGE & DOCK CO., CHICAGO, ILL.

Smokeless combustion of bituminous coal is a problem that has had the attention of engineers and scientists for many years, in fact, ever since the invention of the steam engine made the generation of steam an important factor in producing power. Watt, after bringing the steam engine to a practical degree of usefulness, is said to have turned his attention to it, and with a considerable measure of success. His efforts have been supplemented by other inventors, in his time and ever since, with more or less success.

Upon taking charge of the plant of the Great Lakes Dredge & Dock Company, as Mechanical Engineer, a little over two years ago, I was confronted with this problem in a more serious manner than at any previous time in my career. I realized that we had an ordinance in Chicago and inspectors to enforce it more earnestly than had been the case at any previous time. I found the boilers in our plant, generally, in no shape, theoretically at least, to work economically or generate steam without making considerable smoke. Our tugs are principally fitted with high pressure engines and marine fire box boilers. The boilers ranging from 100 to 300 H. P. We have a number of tugs equipped with compound condensing engines, some with Scotch boilers, some with marine fire box boilers. These tugs range from 350 to 600 H. P. The tugs, generally in the rivers and harbors of the Great Lakes, are high powered for the size of their hulls.

In my efforts to get things in shape, I determined to follow as much of the theoretical idea in preventing smoke and burning coal economically as I could, and combine what my experience as an engineer had taught me was practical. One of the theoretical ideas generally accepted as true is the necessity of plenty of air for combustion. One pound of coal requires, for perfect combustion, 150 cu. ft. of air. In practice this is found insufficient to maintain the draft, nor can it be expected this air will be distributed to give the right amount at the right place all the time. It is practically necessary, therefore, to provide a large excess of air, and the amount actually passing into the furnace is usually not less than 225 ft. and upwards. This extra air is one of the causes of imperfect combustion. It is possible to have smokeless combustion under these conditions, but not perfect combustion. There are two essential principles to smokeless combustion: First, that the fuel be prepared in a certain manner before combustion begins or is completed; second, the exact quantity of air necessary for perfect combustion must be automatically supplied. If soft coal is converted into coke, it can be burned without smoke.

Many furnaces have been designed that fulfill the requirements, and some have proved remarkably successful in producing economy and preventing smoke, but such furnaces are not adaptable to tug boats, though we have a number in use in dredges and ashore. On our dredge No. 52, at work on the Hudson River between Albany and Troy, we have a Scotch boiler 10 ft. in diameter by 15 ft. long, equipped with what is known as the Burke stoker. This is a Dutch oven type of extension furnace placed in front of the boiler. On this boiler we have a stack 75 ft. high by 48 inches diameter. This boiler furnishes steam for 600 I. H. P. All high pressure engines on a fuel consumption of about 1,000 pounds per hour. Smoke is never seen issuing from this stack. We have another dredge at Buffalo with a McKenzie furnace. This is another type of Dutch oven extension furnace placed in front of Scotch boilers. The stack is 105 feet high, 5 feet in diameter. These boilers furnish steam for about 1,500 I. H. P. The stack is also clean in regard to smoke.

The second important principle, that of automatic regulation of the right amount of air to chemically combine with the coal, is also not so easily taken care of in our boilers afloat as in stationary practice. Depending on hand regulation of the opening and closing of dampers and draft doors is very unsatisfactory; however, that is the way we are operating today and we are keeping the smoke down and also effecting some saving in coal.

Among the first things I did to get our boilers into condition to run in this manner was to increase the length of smokestack, increase the area of ash pan openings, increase the air area between grate bars (we are not using any common grate bars with less than 50% air opening now), increase the air openings in furnace doors and furnace fronts very much, in some cases having special doors made to permit larger increase in air over the fire. Where it is possible without making too extensive changes to the up-takes, etc., the stack area is made equal to or 20% greater than the flue area. We adopted devices to admit air in bridge walls of furnaces in Scotch type of boilers, the amount of air that can be admitted to Scotch boiler furnaces being limited by the size. Non-condensing tugs are generally equipped with a blast nozzle at the base of the stack of an area equal to about one-third the area of the exhaust pipe from the engine. I adopted every device which good practice indicated was valuable to make the generation of steam more economical, such as feed water heaters which make use of waste steam and waste gases. Devices to increase the circulation of the water in Scotch boilers have been put in every Scotch boiler in service in our company's plant. Patent tube blowers to keep the soot blown out at regular periods without necessitating the opening of connection doors. We also took every means to clean the water side of all fire sheets of scale and keep them clean. The fireman is the man held responsible for the smoke, but the co-operation of the engineer is necessary. The captain can keep the engineers posted as to the movements of the boat and the engineer must do his part by maintaining steady water levels, using the exhaust in the stack at the proper time and by exercising proper discipline over his firemen.

We then started a campaign of education to teach our firemen the principles of smokeless combustion, the proper sizing of coal, proper admission of air at the right time, proper amount of coal at a period of firing. It is a hard job to teach an old dog new tricks, and I have had to use every means usually employed, and some not commonly used, to accomplish this object. One point I impressed on our firemen was that a large amount of air was necessary for good combustion, and that the air must touch the fuel burned; the more intimately the air mixed with the fuel, the more perfect the combustion. As an illustration of this, take a lump of coal 6 inches in all dimensions. It would have 216 sq. in. of surface. If the lump were broken into 1-in. pieces, there would be 216 of these pieces, and each would have 6 sq. in. of surface, or 1,296 sq. in. in the 216 pieces, as against the 216 sq. in. in the 6-in. lump. We use a good grade of Kentucky coal, or a lower Illinois coal, mine run size.

I also made special efforts to have them fire lighter at short periods, alternating fires where there were two or more furnaces, or firing one-half of the grate at a time when there was only one furnace.

These instructions, with the careful use of the exhaust blast in stacks on high pressure tugs, and a steam jet in the stack on low pressure or condensing tugs, and cracking the furnace door slightly immediately after firing, for a period of about two minutes, sufficed to keep the smoke down to a minimum on our tugs. The fire holds of tugs are hot, small and generally not easy of access, and carrying out this program necessitates more frequent trips to the fire hold. The fireman has contrivances of various kinds to manipulate the furnace doors and dampers and blowers from on deck without going into the fire hold. Firing is a trade which requires study, good judgment and attention. When we consider that a fireman uses up anywhere from 1,000 to 3,000 pounds of coal an hour, at a cost of from $2.00 to $6.00, or, say, from $20.00 to $50.00 worth a day, or $6,000 to $15,000 a year, how many other employes of a company who are spending or using as much of the company's money as they are receiving as little pay as they do?

I found an offer of a small bonus of money at the end of the month to each fireman who had no smoke violations reported on his tug by the inspectors had considerable effect in keeping the fireman up to his job and proved my contention over and over again that soft coal could be burned in our boilers without making smoke. The human element enters largely into demonstrations of this kind, and is the uncertain element we have to contend with. You can get coal of proper analysis for your furnaces; there is plenty of air; you can be assured of the co-operation of the inventors and manufacturers of boilers and furnaces; but after all, you are dependent to a great extent on the operator.

As all the air necessary for combustion must be drawn through the furnace and is moved by the draft power of the stack, it seems to me that there is the proper place to begin. The stack should be of such proportions as to enable us to have a surplus of draft above what is needed. The design of the stack is, therefore, of considerable importance, and should be carefully made. In designing stacks for our boilers, I use William Kent's table.

Openings through grates as well as ash pan openings should not be lost sight of. I do not think, from the standpoint of proper combustion, it is possible to admit too much air through the grates. I believe the principle of efficient combustion will be best served if the percentage of air openings in the grates be as large as possible, without causing loss of fuel through the grates. I advocate the use of the shaking grate, for the reason that they, by reason of their design, generally have a greater percentage of air than plain, straight grates, and also have the advantage of being easily kept clean and free of ashes and clinkers.

The proper theory in ash pan openings I would state in few words: The opening should be sufficient to insure atmospheric pressure under the fire when working at maximum fuel rate. This is difficult to reach in our boilers, but the minimum ash pan opening should equal the total tube area of the boiler, or be not less than 15% of the grate area.

Firing properly is not all. Clean surfaces on fire and water side are necessary. The main business of a boiler is to transmit heat from the fire through the metal to the water, and if on the water side there is scale to the thickness of one-sixteenth of an inch or more, it is goodnight to about ten per cent of your heat units.

It is just as bad economy to let soot collect on the fire surfaces. It is not any better conductor of heat than scale. I consider an efficient soot blower device on a boiler is just as essential as a good water column or a stop valve.

To make the education of our firemen in each division complete on the elimination of the smoke question, I have made it a practice to write a letter each week on some part of the subject. These letters are addressed to the division managers, who then disseminate this knowledge amongst the firemen. We also have, on each one of our machines, cards framed under glass containing the rules for the prevention of smoke as stated in this paper:

Rule 1. Fire one furnace (or part of a furnace if the boiler has only one furnace) at a time, waiting until the fire has ceased smoking before the other door or part of the furnace is fired.

Rule 2. Leave the doors slightly ajar for about two minutes after the fire, or until after smoke ceases.

Rule 3. Fire often at regular intervals and in small quantities.

Rule 4. Keep the fire clean, bright underneath and ash pans clear of ashes.

Rule 5. Carry level surfaces over the entire grate area, avoid thin or bare spots and keep the corners full.

Rule 6. Break lump coal to small sizes, using no lumps larger than your fist.

Rule 7. Use the steam jet or exhaust in the stack to assist in the prevention of the smoke with care and judgment that it be not excessive.

PRESIDENT TOWNER: Has any one any questions he would like to ask Mr. Peck on this paper? If not, we will proceed to the next paper on the program, which is "Smokeless Combustion as Applied to the Burning of Clay Products," by Mr. A. W. Clement, Des Moines, Iowa.

SECRETARY VIALL: I have received a letter written by Mr. Clement in which he says, in one paragraph, that at the last moment he has found it impossible to be present here at the Convention, and he asks that his paper be read.

PRESIDENT TOWNER: Will some one volunteer to read the paper by Mr. Clement?

Mr. Porter volunteered and read the paper as follows:

SMOKELESS COMBUSTION AS APPLIED TO BURNING OF CLAY PRODUCTS.

A. W. CLEMENT, DES MOINES, IOWA.

Strictly speaking, the title of this paper does not correctly indicate the rather narrow confines to which the writer is held by reason of his limited experience.

I am compelled by reason of this lack of wide experience to limit myself to a much smaller field than the title would warrant.

My work in this line has been wholly in the city of Des Moines and has had to do with the observation of the performance of but one type of device which is used in burning clay products. However, in view of the fact that from all that I can learn, the burning of clay products without objectionable smoke, with high volatile coal, has only very recently been recognized as commercially possible, the restricted nature of this very elementary discussion may be overlooked.

If it may appear that I am devoting the time to a presentation of the peculiar merits of one particular device, it is only because my report to you on its construction and operation is the only thing that I can offer you, which is the result of actual observation and study on my part. My interest in the device is solely that of a Smoke Inspector.

Reports of the Smoke Inspectors of other cities seem to indicate that it has been quite generally thought that the smoke from kilns where clay products were burned was an evil which must be endured. It has even been stated that the only means for relieving a city of the smoke nuisance from brick kilns was to provide for their location in such a district that the smoke from them would have a minimum effect on the community. Combustion engineering seems to have balked at the problem of convincing owners of clay burning plants that smoke was not a necessary incident to the process of producing their ware, when soft coal was used for fuel. Such a condition is surely not flattering to the able engineering talent that has been devoted to smoke abatement and it is interesting to know why this is the case.

The burning of various clay products demands a highly specialized skill, only acquired by long practice and experience. Most clays consist of a mechanical mixture of very complex chemical constituents. An entire bed or pit of clay is not homogeneous; at different times in the course of the operation of the plant, the character of the clay changes slightly. It will demand different treatment to get the proper color, texture and strength of product. To secure the desired results is largely a matter of experiment in proper mixture and treatment of the clays or shale.

I think that I am correct in saying that this manipulation of the fires is largely left to a personage known as the "burner." He acquires, by long experience, an almost intuitive knowledge of his art which enables him to anticipate what kind of treatment will bring the desired results. His eye becomes a sort of optical pyrometer. With one knowing squint into a peephole, he comprehensively defies all modern contraptions which may be intended to check up on conditions. The fate of the product, or the "ware," as it is generally known, lies in his hands. While the owner of the plant hovers in the distance, hoping for the best, the "burner" and his intuitive skill becomes a matter of prime importance. It is no wonder, then, that the owner of the plant is often loath to interfere with the methods of the "burner," even though he may not be able to see the reason for them.

It is not intended, by the above remarks, to give the impression that *all* clay burning plants are subject to such conditions; of late years, the introduction of scientific methods of checking up operations, the use of recording instruments, etc., has become more general. I think that it is still true, however, that, generally speaking, the "burner" holds a peculiar and unique position somewhat similar to that of a "brewmaster" in a brewery, a "yeastmaker" in a distillery or that of the man who watches the flame from a Bessemer converter. Woe be to the man who disputes his prerogatives or questions his methods!

It is a safe prediction that if any one of you should inquire of the "burner" whom you may next meet, "Is it possible to burn your product, using soft coal, and not make smoke?" he will answer with a positive, "No." If you should persist in knowing why, you will be met by certain statements regarding the peculiar conditions which may be required for that particular "ware" or that particular clay, something regarding the required color or the kind of kiln or the qualities of the coal, etc., etc. Unless the inquirer be unusually constituted, he will find himself in a position where he is unable to contradict such statements. He will find himself lost in a maze of technicalities which concern a business with which he is not sufficiently familiar to be sure of his ground. The manager or proprietor of the plant is likely to be in a position where he does not care to antagonize his "burner," especially if he is getting good results in quality of his ware. Thus the conscientious Smoke Inspector finds himself up against a stone wall of what to him will appear as obstinacy, pure and simple.

This seems to explain, to a certain extent, why it has generally been conceded that the best place for a clay-burning plant was outside of the city limits.

If I shall be able to offer some facts that will tend to dispel this illusion, I may be pardoned for the other shortcomings of this brief and disconnected paper.

There is an almost infinite variety of clays and the products that are made from them. In general, we may describe clays as being mechanical mixtures of silicates of alumina, alkalies, oxides of iron, carbon in various forms, lime, magnesia and sand.

When treated so as to be in a plastic condition the clay is formed into the shape that the product demands. The shapes are then wet; the clay contains water, both as a mechanical mixture and in chemical combination. The excess moisture is generally removed from the shapes by drying them somewhat previous to their being placed in the kiln where they are to be burned.

The first part of the process, within the kiln, is de-hydration, the gradual removal of the chemically combined moisture. In brickyard parlance this is called "water-smoking." This process to be successful must be done with a comparatively low intensity of fire and with an enormously great excess of air drawn freely over every surface of the ware that is exposed to the heat. The resulting physical effect on the ware is to gradually evaporate the moisture and carry it off through the stack, leaving the ware practically dry and thus opening up an infinite number of minute pores between the particles of the clay.

The water that is mechanically carried by the clay can be driven off at a temperature of 212 deg. F. or slightly higher. The water that is chemically combined requires a temperature of from 750 deg. F. to 1100 deg. F.

As ordinarily carried on, in the common fire-boxes, this is a smoky operation, as its name indicates. A low fire is usually carried on the crude grates provided and much air is drawn through this fuel bed, through the openings between the grate bars. Air is also admitted over the fire. This results in just such a condition as we are all familiar with in a boiler plant.

The fuel bed burns thin, due to the active combustion, and when the fuel needs replenishing more is thrown on top of the incandescent coke and ash. This results in the usual cycle of active gas formation, smoke, devolatilization and burning of the fixed carbon.

When the moisture has all been driven off and the pores of the clay shape are opened up, the product is ready for the oxidation period of firing. This is a period of chemical change and it requires the utmost skill and care to carry it through in such a way as to insure all of the required qualities of the product, such as color and strength, and to avoid deformation of shape. During this period the carbon in the clay must be burned out. The de-hydration process has left all of the small pores open so that when the shapes are subjected to a high temperature gas carrying an excess of oxygen, the carbon is gradually converted to carbon dioxide and goes up the stack. This is done at a temperature of from 1472 deg. F. to 1652 deg. F. Below this temperature the oxidation proceeds too slowly and above this temperature there is danger of vitrification beginning so that the outside of the pores will become closed and no more gas can enter to act on the enclosed carbon.

This is also a critical period as regards the proper formation of required color. The most active coloring agent in clays is iron in the form of one of its oxides, either ferrous oxide, FeO, or ferric oxide, Fe_2O_3. If ferric oxide is not completely oxidized to ferrous oxide, by supplying an excess of air at high temperature, this remaining ferric oxide beneath the surface will later form a fusible flux and injure the quality of the product. However, the carbon must all be burned out first because the carbon has a much stronger affinity for oxygen, and thus, as long as it remains in the clay it will monopolize all of the supply of oxygen carried in by the excess air.

The desired color for some products is arrived at by using a reducing flame, that is, one carrying a deficiency of oxygen, thus changing the "ous" oxides to "ic" oxides.

It will thus be seen that the requirements for the fire in this stage of the process are such that we must have complete control of the air supply. The temperature of the inside of the kiln and of the fire-brick surrounding the fire-box itself has been gradually raised to a point where it does not chill the flame. The rate of combustion of the coal has been raised to such a point that the fire will require cleaning occasionally. In the ordinary type of fire-box this cleaning means that the whole fuel bed be more or less torn up; punched between the grate bars, the clinkers hooked out and practically a new fuel-bed built up. This cleaning operation thus means, ordinarily, smoke as well as a temporary lowering of temperature within the kiln and possible chilling the ware. To avoid this condition there is but one solution, viz., the substitution of means to accomplish a practically *continuous firing* operation, such as we are familiar with in stokers and some semi-stokers. I think that you will agree with me that complete air control, combined with a continuous firing operation, which will allow of ash removal without disturbing the fuel bed, is not inconsistent with smoke prevention, especially when we have the added advantage of having high temperature assured by the presence of hot fire-brick all around and above the fire. Under such conditions, it is even possible to supply gases carrying a deficiency of oxygen, namely, carbon monoxide in considerable quantities, without producing black smoke, if it should be required to produce some particular color.

The third stage of the burning process may be called the vitrification period. In this stage the clay shapes are heated to such a temperature that the grains of the clay stick together sufficiently to prevent the recognition of any except the coarser ones. Further heating closes all of the pores and renders the product impervious.

The manipulation of the fires during this period requires care to see that the kiln and the ware in it shall be subjected to a "soaking" heat, the gases must permeate the kiln, fill it up and cause a "plenum." The entire mass of ware in the kiln must be equally heated.

During this vitrification period the temperature of the kiln is raised to the highest point that may be required for the particular product. Consequently the supply of air must be diminished because there is no further requirement for oxidation except as it may affect color or toughness. At this time the ware has become more or less incandescent, the fire-brick surrounding the fire-boxes has become well heated throughout and, if it were not for the necessity of cleaning fires, there would be no reason for making smoke. All of the other requisites for good combustion are present. Again, the only solution for the elimination of smoke due to the operation of cleaning fires is a practically continuous firing operation, similar to the cycle with which we are familiar on a chain grate.

Now, after having briefly outlined the nature of the firing operations required to bring the ware from the wet, plastic state to the finished, vitrified product, it seems to be clear that the two indispensable feaures of any fire-box which may be used successfully with high volatile coal, and, at the same time be smokeless, are:

(1) Complete control of the air supply.

(2) Continuous, or rather, progressive fuel burning.

Certainly, these things do not appear to be very difficult of accomplishment from an engineering standpoint. We are familiar with many types of furnaces as now used in steam generation, which function perfectly along these lines. However, there are considerations involved in the clay burning industry which do not allow the conditions to be compared with the conditions in a boiler plant.

Comparatively speaking, the life of a kiln is short. They are generally so located that it would be impossible to use a mechanically operated fuel feeding mechanism. They are often exposed to the weather for long periods and may lie idle for a considerable time. It is not unusual to have several hundred fire-boxes in a single clay burning plant.

It then becomes a prime consideration that the commercially adaptable fire-box shall be low in first cost, low in cost of maintenance, shall be hand-operated, and shall be economical of fuel, as well as being capable of manipulation so as to secure the desired results with the peculiar ware to be produced. Therefore, the problem is not quite so simple as it may at first sight appear. I should perhaps add that the type of fire-box may not be so radically different from the kind that has been in general use that it would require specially skilled men to operate it, or such that it would arouse violent prejudice on the part of the men who have been accustomed to the old and rather primitive type of fire-box.

Since I could not arrange in a better way, I have been supplied with a number of pamphlets on which there is a cut showing the construction of "The Grateless Gravity Feed Fire-box," as developed by the Grateless Furnace Co. of Des Moines, Iowa, of which Mr. Paul Beer is president and general manager. It was my idea to have these pamphlets passed among the audience so that those interested could look over the cuts while a brief explanation is made.

The fire-box proper is rectangular and may be from 24 inches to 36 inches wide between side walls. There is a solid, sloping, fire-brick covered "fuel table" extending from side wall to side wall. The upper portion of this "fuel table" (marked in the cut "firing hole") has an "ignition arch" thrown over it. Immediately back of this "ignition arch" is a "drop arch" or "baffle arch."

Through this "baffle arch" there is an opening marked "over-draft opening." Still back of this arch is a combustion chamber, which is also arched over with fire-brick. Underneath this "fuel table" is the "ash pit." Dimensions vary according to special requirements.

The shape of the fuel bed differs at different periods of the firing of the kiln.

During the "de-hydration" period, when the intensity of the heat in the kiln is low, and a great excess of air is required, the fuel bed fills the space below the bottom of the "coking-plate." The upper portion of the fire-box remains fully open and unobstructed to admit the excess air that is needed. The rate of combustion is very low at this time and the fires do not need cleaning. The fuel bed is thick, the air to support combustion being supplied by the slight draft through the opening underneath the "fuel-bed." This draft is very low in intensity, due to the fact that the whole upper portion of the fire-box is open.

As the de-hydration period is being completed the coal is thrown in through the "firing hole" and down the "fuel table" past the "baffle arch," thus filling the lower portion of the fire-box, the fuel reaching part way up the "fuel table." As the fires need cleaning, the ash and clinker is removed from the portion of the fuel bed directly underneath the bottom edge of the "coking plate," fresh, devolatilized fuel falling down to replace ash. As the ware is being gradually brought from the de-hydrating stage to the oxidation period, the intensity of the heat is increased, the rate of combustion is greater, the fire-brick around the fire-box being gradually brought up to a cherry red. The "fuel table" now begins to function as its name indicates, the heat reflected from the arch above serving to drive off the volatile hydro-carbons, which are made to pass over the incandescent bed of coked fuel below. The air to burn this coked bed of fuel below is supplied from the front of the ash pit below which is entirely open to the atmosphere, there being no grate bars. As we have before stated, there must be an excess of oxygen at a temperature of from 1472 deg. F. to 1652 deg. F. during this oxidation period, hence the space between the "baffle arch" and the "fuel table" in the upper part of the fire-box is left partially open, admitting an excess of air over the fire. This excess air is, however, made to pass under the "baffle arch" and thus forced into intimate mixture with the volatile hydro-carbons being driven off from the fresh fuel on the "fuel bed," and then passed over the incandescent fuel bed in the lower part of the fire-box. This results in practically smokeless combustion, especially in view of the fact that there must be a thorough mixing of gases due to the checker-work effect of the ware as it is piled in the kiln. The progressive firing is of course the real reason why it is comparatively easy to avoid smoke. The cleaning of fire is accomplished without disturbing the uncoked fuel at the top.

Now, as the vitrification period approaches, the temperature is to be raised and the supply of air decreased. Hence the fuel bed is carried up higher on the "fuel table," closing the opening between the "baffle arch" and the "fuel table." The "firing hole" is filled with fresh coal, thus cutting off all air over the fire except such as may be allowed to pass through the small hole in the "baffle arch." This partial closing of the air admission over the fire, of course, increases the intensity of the draft through the lower portion of the fuel bed, thus increasing the rate of combustion. This condition results in raising the temperature of the kiln to the point required for vitrification. It will be noted that the rate of air supply is completely within the control of the burner as he may change it at any time by altering the amount of opening over the fire, even by closing the small opening in the "baffle arch" if necessary. He may also control the air admission through the incandescent fuel bed at the bottom by regulating his cleaning period according to the rate of combustion required. Now, when the fire-box is in the condition in which we find it during the vitrification period, it is perfectly feasible to produce a *reducing gas,* that is, a gas deficient in oxygen without producing any visible smoke. The fire-box is entirely surrounded by white-hot fire brick, the hydro-carbons driven off from the fresh coal in the firing hole mix with air at the "bafflle-arch" and burn to carbon dioxide which in turn is passed over and into intimate contact with incandescent fixed carbon. The carbon dioxide is reduced to carbon monoxide, which will again combine with another atom of oxygen within the kiln, if there is any iron oxide or other "ous" compound to give any oxygen. It is sometimes not properly realized that the production of carbon monoxide is not necessarily accompanied by smoke.

I have attempted to describe as well as I could under the circumstances the requirements of a fire to give the desired results in burning the most of the common clay products. I have also described, in a rather unsatisfactory way, I fear, the construction of the Grateless Fire-box and the method of firing it to accomplish these results. As to the matter of actual observation of the performance of these fire-boxes in regular daily practice, I can assure you that they are smokeless, within the meaning of any smoke ordinance with which I am familiar, even when using the lowest grades of coal, high in volatile and high in ash and clinker. Their smokeless operation is an incident to their economical performance; it is not the main object in view, in fact, the development of the fire-box has not been with that matter in mind, particularly.

Saving in fuel consumption and saving in time required to complete a burn has been the end in view. At the plant of the Barber Asphalt Paving Co. in this city, the introduction of the Grateless Gravity Feed Fire-box has resulted in a saving of fuel that is hardly credible. A recent report which is attached herewith states that the saving in fuel per kiln per burn amounts to $57.50, or a total saving at the plant of $4,657.50 for a period of five months. The average burning time, previous to the introduction of the improved fire-box was 11 days and 8.7 hours. This has been reduced to 9 days and 14.3 hours. Their product is paving brick. This same improved fire-box is in use in a sufficient number of plants, making various clay products to make it reasonably sure that smokeless operation may be accomplished in almost any plant of a similar nature. A list of representative plants follows:

Common Brick—Shakelford Brick Company, Des Moines; Tramp Bros., Creston, Iowa.

Drain Tile, Hollow Block and Hollow Face Block—Straight Bros., Adel, Iowa; Harvey Brick & Tile Co., Harvey, Iowa.

Drain Tile—Kalo Brick & Tile Co., Otho, Iowa.

Pottery—Universal Sanitary Mfg. Co., New Castle, Pa.

Fire Brick—Mexico Brick & Fire Clay Co., Mexico, Mo.

Silica Brick—American Refractories Co., Joliet, Ill.

Paving Brick—Bessemer Limestone Co., Youngstown, Ohio; Barber Asphalt Paving Co., Des Moines, Iowa.

Front Brick—Des Moines Clay Co., Des Moines, Iowa; Boone Brick, Tile & Paving Co., Boone, Iowa; Anthony Ittner Brick Co., Belleville, Ill.

As I have before remarked, if this paper seems to savor of too confined presentation of the merits of one particular device, my excuse must be that it is the only means that I have for giving to you the results of my actual observation of smokeless combustion as applied to the burning of clay products. There may be other and just as good means in use elsewhere, but I have no personal knowledge of them.

I have indicated what the requirements are for the conditions under consideration and I am sure that there can be no objection to any of you who may be interested in the subject exercising your inventive genius in the effort to produce something else that will answer the purpose.

The point which I hope to have made is that smoke is not a necessary adjunct of a clay burning plant and that it may be abated, yes, even eliminated, not at a sacrifice of economy, nor at an enormous first cost, but with an accompanying financial advantage to the plant owner. Trusting that some of you may go forth with a conviction that the clay burning plants of the future will be smokeless and, above all, that you may have the strength of your convictions, I remain,

Yours cordially,
A. W. Clement.

DISCUSSION.

President Towner: Is there any discussion on this paper?

William A. Hoffman, City Smoke Inspector, St. Louis, Mo.: I desire to make a few remarks relative to the grateless fire-box that Mr. Clement described. I visited Des Moines two years ago and witnessed the operation of this fire-box on a pressed red brick kiln. I did not have the opportunity to witness the burning of brick such is used in our vicinity, St. Louis, namely fire-brick.

About three months ago there was installed in a red-brick plant in Belleville, Ill., fourteen miles from St. Louis, a kiln with these grateless fire-boxes. It was an old rectangular red-brick kiln, down draft, with nine holes on each side. I witnessed the full firing period. In that time there was no dense smoke emitted from the stack. The color of the smoke during the full firing period was a slate color. This slate colored smoke disappeared within 50 feet of the stack. In other words, beyond that radius stack was clear.

A great degree of heat can be generated and maintained in this grateless fire-box. There are no grate bars where air enters directly underneath the fuel.

I witnessed the placing of a good size lump of coal, perhaps eight or ten inches long, and three inches thick, and six inches wide, on the top of the fire-box, or in the front of the fire-box. The flame easily came up and burned on the furnace edge, or the edge of the lump of coal that was exposed to the furnace. I placed my hand on the front part of the lump with all of the comfort that one might desire. The flame had a tendency to come right up to the coal as it is fired into the furnace. This furnace also can burn slack coal. In our territory we are very much interested in this or any other smoke prevention device that will apply to kilns, particularly to brick kilns, of which I suppose we have 150 in the city of St. Louis.

PRESIDENT TOWNER: Is there anything else to be said on this subject?

J. W. HENDERSON, City Smoke Inspector, Pittsburgh, Pa.: I did not hear all of this paper on account of being busy on this Ways and Means Committee proposition during the reading of a part of it at least; but one of the purposes of my going to Chicago and other cities last year was to investigate what could be done about smokeless operation of brick kilns, because Pittsburgh has quite a number of brick kilns right in the city limits. We have the old style kiln, and the kilns have the Boss system of furnaces and they also want to introduce draft brick kiln continuous operation.

During my peregrinations I visited Philadelphia and saw a continuous plant there where they used no grate, but simply put the coal over the dead plate, it being a natural draft continuous proposition. They showed me their fuel cost, but I promised them not to give the exact figures out. I would say that they were phenomenally low, compared to all our kilns in Pittsburgh. Of course our brick men say that they have a different kind of clay and it makes a difference; and you can get around a great many things on the question of the quality of the clay, and the different temperatures at which one clay can be burned as compared with another. But this continuous kiln down in Philadelphia was operating without even No. 1 smoke. It was a 15,000,000 brick proposition, and it was very interesting to me, because while they were using Pittsburgh coal and paying a high price for it, their fuel cost per 1,000 brick was lower than the Pittsburgh kilns. We have tried to get them to change their firing methods in the brick kilns at Pittsburgh. The way they have been doing it, the man on one side starts with the odd numbered doors, and the man on the opposite side starts firing the doors with even numbers, so that when they both get through they have fired both sides, and yet they have not been opposite each other, and that reduces the smoke considerably, especially if they fire in small quantities. We have obtained in some cases some very interesting figures as to cost per 1,000 brick. The brick proposition is a very difficult one, because the competition is very keen, and they consider themselves very lucky if they make $1.00 profit per 1,000 brick. The particular thing that I wanted to get into the record is that it is possible to burn smokeless continuous kilns if they are properly constructed and operated.

W. E. Porter, Asst. Chief Smoke Inspector, Pittsburgh, Pa.: In Pittsburgh the ordinary brick kilns have say, 20 furnaces on either side, and they get a "burner" as they call him, a fireman, and the thing is to get him to give attention to the type of coal and fire it in a scientific way, to give it as much attention as would be required in either of these special furnaces. The "burner" can bring kiln within the smoke ordinance of almost any city, but they will not do it, because as it was referred to in the paper, the ordinary burner is a man of very positive convictions. We came across one case where the burner had been with the father of the proprietors of the plant and was still with the sons, and you could not get him to believe anything that you said, or to change his method of firing one bit. The proprietors said that they were afraid to interfere with him because he knew better how to burn brick than any man in America. I suppose they were paying him almost $1.50 a day, and he is laid off about half the time in the year.

Emil Fleigerer, City Smoke Inspector, Syracuse, N. Y.: We have a number of brick kilns in Syracuse, some of them the largest in the country. I went after these people, and the problem was very difficult at the start, because they all claimed that nothing could be done, that they had to use soft coal. I suggested to them that in firing up they start with low volatile matter fuel, and after the chamber has come to the ignition point they could then fire with any grade of fuel. They adopted this suggestion and the result was very satisfactory, and most economical. At the same time it produced a very moderate amount of moke. We found that the regulation of the oxidizing or reducing flame is entirely within the control of the operator by applying more or less science and art to it.

President Towner: Is there anything further on this subject? If not, we will resume the regular order of business.

J. H. Lewis, Chief Smoke Inspector, C., B. & Q. R. R., Chicago, Ill.: I move that we now take up the matter of proposed new constitution and by-laws reported by the Ways and Means Committee.

The constitution and by-laws as passed are as follows:

CONSTITUTION.

Article 1. "Name." The name of this organization shall be "Smoke Prevention Association."

Article 2. "Object." The object of the Association shall be to bring about co-operation, education, and standardization for the prevention of smoke.

Article 3. "Membership." Any person interested in the objects of this Association may become a member. All members shall be elected by a majority vote of the Membership Committee.

Article 4. "Officers." The officers of the Association shall be, a President, a Vice-President, and a Secretary-Treasurer.

A. The President shall preside at all meetings of the Association, shall appoint all committees, and shall be an ex-officio member of all committees.

B. The Vice-President shall preside in the absence of the President and in the event of his withdrawal or death, shall assume the office of President.

C. The Secretary-Treasurer shall keep a record of the proceedings of the Association; he shall be the custodian of all its records and documents. He shall collect and have charge of its funds and have authority to make disbursements with the exception that he shall make no disbursements in excess of fifty ($50.00) dollars for any specific purpose without the written permission of the President. He shall place all funds in a savings bank in the name of the Association and at each annual meeting he shall present a financial report.

Article 5. "Amendments." This Constitution shall be amended by a three-fourths vote of the members present and voting, at any annual meeting.

BY-LAWS.

MEETINGS.

1. This Association shall meet annually during the month of September. The place of assembly for each annual meeting shall be decided by a majority vote of the members present and voting at the morning session upon the last day of each annual meeting, and the Secretary shall serve notice upon all members of the Association of the place and time of meeting, as decided by the Association, at least thirty days prior thereto.

FEES.

2. The membership fee shall be Five ($5.00) Dollars per capita per annum, which amount must be transmitted to the Secretary-Treasurer on demand. If each amount be not paid annually the Association may strike from the roll the name of the delinquent member.

ELECTION.

3. Officers shall be elected by ballot upon the last day of the meeting of each annual convention, and shall continue in office until their successors have been regularly elected. All officers shall be elected by a majority vote of the members present and voting.

COMMITTEES.

4. The president shall appoint the following standing committees:
    1. Ways and means.
    2. Publicity.
    3. Standardization.
    4. Membership.
    5. Auditing.
    6. Program.

COMPENSATION.

5. The Secretary-Treasurer shall receive a compensation of Fifty ($50.00) Dollars per annum.

ORDER OF BUSINESS.

6. The following shall be the order of business:

1. Reading of minutes of previous meeting.
2. Reception of members.
3. Report of committees.
4. Unfinished business.
5. New buisness.
6. Papers, inquiries, and replies by members.
7. Election of officers.
8. Selection of next place of meeting.
9. Adjournment.

AMENDMENTS.

7. These by-laws may be amended by a two-thirds vote of those members present and voting at any meeting.

DANIEL MALONEY, City Smoke Inspector, Newark, N. J.: Mr. President and Gentlemen: I have a resolution which I would like to offer, and which I will ask the stenographer to read.

The official stenographer read the resolution as follows:

Whereas, The work of this Association in the past has shown that the propaganda originally started by enthusiasts from ethical, sanitary and artistic reasons, has resulted not simply in an ideal accomplishment contributing nothing to the useful arts and sciences, but on the contrary has been the means of initiating investigations which have resulted in the most practical benefits to mankind and improved the efficiency and caused greater saving in operation of all machinery actuated by steam; and

Whereas, The work of the Association has now so broadened in its scope that it requires greater means in financing its work in order to carry forward and insure that the best results shall be hereafter obtained; therefore,

Be it Resolved, That a Committee on Finance consisting of three members be appointed, whose duty it shall be to devise a practical plan for securing the financial support of those employing steam in their plants, railroad and steamboat interests, and all others who have made savings in economy of operation and have derived other benefits from the work of this Association.

DANIEL MALONEY, City Smoke Inspector, Newark, N. J.: I would like to say that the purpose of offering this resolution is of broadening the field of membership, that is bringing in Associate members. I think it would have that effect, and that is the purpose of it.

PRESIDENT TOWNER: There are no Associate members in this organization.

DANIEL MALONEY, City Smoke Inspector, Newark, N. J.: Well, active members.

The motion to adopt the resolution was now put by the Chair, and the resolution was lost by a vote of five ayes and seven nays.

DANIEL MALONEY, City Smoke Inspector, Newark, N. J.: I do not believe, Mr. President, that the members understood the purport of that resolution.

PRESIDENT TOWNER: I think it is all covered in our Constitution at the present time.

DANIEL MALONEY, City Smoke Inspector, Newark, N. J.: It proposed to appoint a Finance Committee to go out and get money to support this organization.

PRESIDENT TOWNER: That is what we have a Committee on Ways and Means for, to devise means for promoting this organization.

The next order of business is roll call. We have not had a roll call of this organization since the Convention has been called to order. You will kindly answer as your names are called, and we will see how many we have present.

The Secretary proceeded with the roll call.

As the result of the Roll Call, President Towner announced that the total paid membership at the Convention was sixty, and that fifty of these paid members were represented at the present session, which showed a good representation for the last day.

PRESIDENT TOWNER: The next order of business, gentlemen, is the election of officers:

Wm. A. Hoffman, Smoke Inspector of St. Louis, was nominated and unanimously elected as President of the Association.

Chas. W. Heath, Smoke Inspector of Cincinnati, was nominated and unanimously elected as Vice-President of the Association.

Frank A. Chambers, Mechanical Engineer, of Chicago, was nominated and unanimously elected as Secretary and Treasurer of the Association.

The Secretary then read invitations extended by Atlantic City, Baltimore, Niagara Falls, Pittsburgh, Buffalo, Columbus, Newark, and St. Louis for the 1916 convention of the Smoke Prevention Association. The matter was put to a vote and there was a total of 49 votes cast, of which St. Louis received 27, Columbus 12, and Newark 10. St. Louis was therefore declared the next convention city for 1916.

William A. Hoffman, City Smoke Inspector, St. Louis, Mo.: I wish to move at this time that the thanks of this Convention be tendered to Mr. Charles W. Heath, City Smoke Inspector of Cincinnati, for the culmination of this most successful Convention, and also for the untiring efforts put forth by Mr. Heath and his local committee in the preparation of the details; also to the Mayor of the city of Cincinnati, Hon. Frederick S. Spiegel; to the United Smoke Committees, and to the other constituent bodies, to the Chamber of Commerce, the Smoke Abatement League, the Business Men's Clubs, the Federated Improvement Associations, the Engineers' Club of Cincinnati, the American Chemical Society (Cincinnati Section), the American Institute of Architects (Cincinnati Section), the City Club, the Academy of Medicine, the National Association of Stationary Engineers No. 15, the National Association of Stationary Engineers No. 36, the International Union of Steam and Operating Engineers No. 18, to the Local Entertainment Committee and their ladies, to the Press, and to all those who have manifested kindly and friendly interest in this Association, and in our entertainment here.

The motion was seconded and carried by unanimous and rising vote.

President Towner: The next order of business is the installation of officers to serve for the ensuing year. The officers-elect will come forward. I will now turn the gavel over to the President. Mr. President-elect, I present you this gavel, and trust that you will wield it as fairly and squarely to all concerned as I have tried to do. I deliver to you the gavel of authority of this organization.

President-elect Hoffman: Mr. Chairman and Members of this Association: I accept this gavel as the emblem of authority and promise to wield it to the best of the judgment that I possess.

Ex-President Towner: Now I would move that this Convention adjourn until our 1916 Convention in St. Louis.

Motion carried, and the Convention adjourned accordingly.

ILLINOIS CENTRAL

Chosen as the Official Route of the

SMOKE PREVENTION ASSOCIATION

TO ST. LOUIS

where the Eleventh Annual Convention will be held during September 1916

DAYLIGHT AND DIAMOND SPECIAL SERVICE

ALL STEEL TRAINS

Buffet Club Cars—Observation Parlor Cars
Sleeping Cars—Chair Cars

DAYLIGHT SPECIAL Leaves Chicago 10:02 A. M.
Arrives St. Louis 5:46 P. M.

DIAMOND SPECIAL Loaves Chicago 10:30 P. M.
Arrives St. Louis 7:48 A. M.

Tickets, sleeping car reservations and further particulars may be obtained of

R. J. CARMICHAEL
Division Passenger Agent
76 West Adams Street, Phones: Central 6270; Auto. 64-472

Stop Wasting Coal and Cut Heating Costs

70 to 80 tons of cheap soft coal, burned in a Kewanee Smokeless Boiler, will make as much heat as 100 tons of the same coal burned in a boiler not properly constructed to burn soft coal smokelessly.

This is possible because a Kewanee Smokeless Boiler burns the cheap soft coals so completely that none of their valuable heat making gases get up the stack unburned and cause smoke. With the ordinary type boiler about one-third of its fuel is wasted.

Hennepin Ave. M. E. Church, Minneapolis
Hewitt & Brown, Architects.
Kewanee Smokeless Boilers installed by
Tunstead Heating Company.

KEWANEE

Smokeless Boilers
CUT HEATING COSTS

It makes no difference whether a building is in a city enforcing a smoke ordinance or not. The low cost way to heat any building is to burn soft coal—and burn it smokelessly.

You will find Kewanee Smokeless Boilers heating the best buildings of all kinds in all parts of the country.

Our new booklet "Kewanee Smokeless Boilers on the Job," tells why. May we send it to you?

KEWANEE BOILER COMPANY
Kewanee, Illinois
Steel Heating Boilers, Radiators, Garbage Burners
Chicago, New York, St. Louis, Kansas City, Minneapolis, Pittsburgh

The Frost Manufacturing Company

(ESTABLISHED 1851)

Works at
Galesburg, Illinois

Builders
of

Frost

Boilers

112 West Adams Street
Merchants Loan and Trust Building
Chicago, Illinois

You Coal But Once a Day

with

Spencer

Steam, Vapor and Hot Water

Heaters

Think of what this means to the "women folks" in the home—getting even heat all the time without the trouble of tending the fire.

We can refer you to scores of our customers who will gladly tell you about their happy experience, with the Spencer Heater.

Not only cutting labor, the "Spencer" saves money on coal bills, too, as it burns the cheap sizes and kinds of coal.

See us before you put in a new heater. We can save you money.

SPENCER HEATER CO.

Railway Exchange Bldg. - - Chicago, Ill.

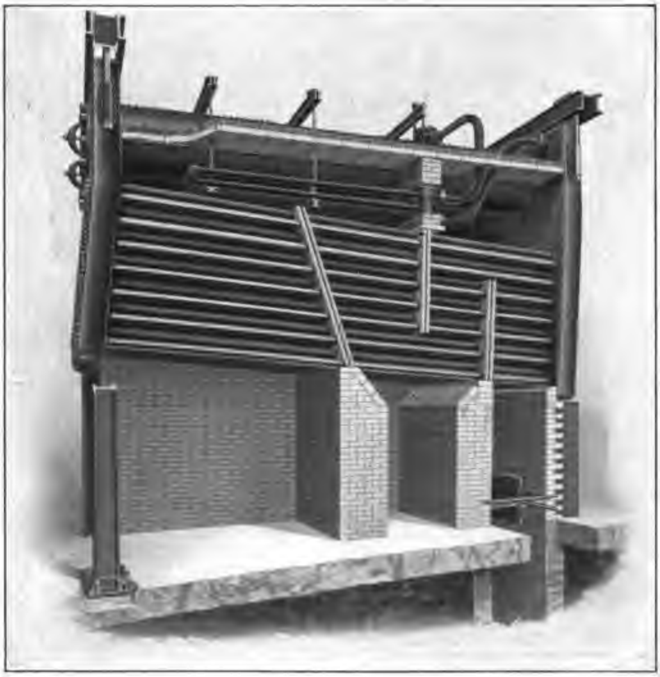
EDGE MOOR IRON COMPANY

Manufacturers of

High-Grade Safety Water Tube Boilers

Branch Offices:
Boston, New York, Chicago

Main Office and Works:
EDGE MOOR, DEL.

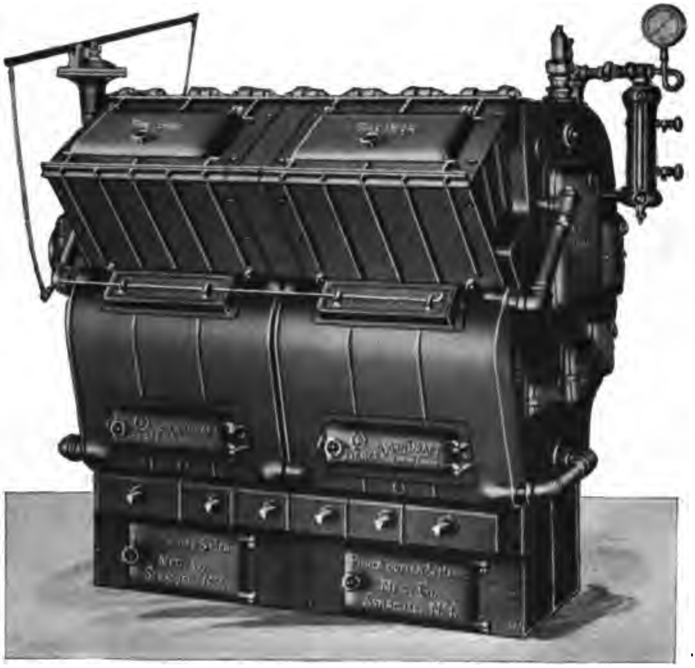


The above boiler is not a Smokeless Boiler, but it will absorb more heat units (liberated by the furnace) than any other boiler made. Send for catalogue and information. 75% efficiency is easy.

Our Contribution to Smoke Abatement!

HAVE YOU SEEN THE "PIERCE" SMOKELESS MAGAZINE FEED BOILER?

It has the approval of Smoke Inspectors in all cities in which it has been tested, meeting all requirements in the matter of Smokelessness. It burns the cheapest grades of soft coal.



"Pierce" Smokeless Magazine Feed Boiler

Magazine Feed Boilers heretofore meant using hard coal exclusively, but the "Pierce" will burn soft coal as effectively as other boilers burn anthracite. Made in various sizes for steam and water. We are in position to fill orders promptly. Let us send you descriptive literature.

THE KELLOGG-MACKAY COMPANY
PLUMBING AND HEATING SUPPLIES
CHICAGO - - - MINNEAPOLIS

PAGE-BURTON WATER TUBE

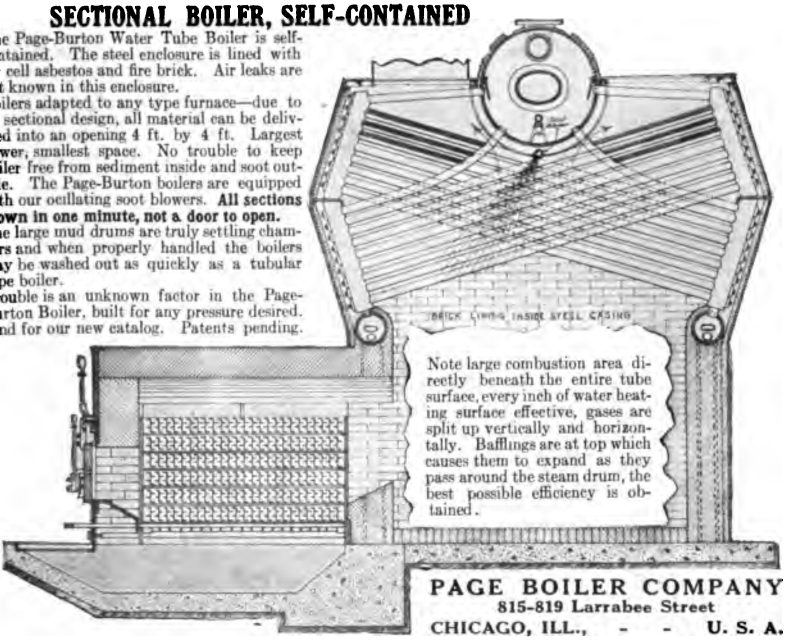
SECTIONAL BOILER, SELF-CONTAINED

The Page-Burton Water Tube Boiler is self-contained. The steel enclosure is lined with air cell asbestos and fire brick. Air leaks are not known in this enclosure.

Boilers adapted to any type furnace—due to its sectional design, all material can be delivered into an opening 4 ft. by 4 ft. Largest power, smallest space. No trouble to keep boiler free from sediment inside and soot outside. The Page-Burton boilers are equipped with our ocillating soot blowers. **All sections blown in one minute, not a door to open.**

The large mud drums are truly settling chambers and when properly handled the boilers may be washed out as quickly as a tubular type boiler.

Trouble is an unknown factor in the Page-Burton Boiler, built for any pressure desired. Send for our new catalog. Patents pending.



Note large combustion area directly beneath the entire tube surface, every inch of water heating surface effective, gases are split up vertically and horizontally. Bafflings are at top which causes them to expand as they pass around the steam drum, the best possible efficiency is obtained.

PAGE BOILER COMPANY
815-819 Larrabee Street
CHICAGO, ILL., - - U. S. A.

The S. Freeman & Son Mfg. Co.

......Manufacturers of......

Horizontal Return Tubular
Horizontal Water Tube and
Internally Fired Type Boilers

Descriptive Literature will be Mailed Upon Request

General Offices and Factory:
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Long Distance Phone 95

Chicago Office:
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Harrison 5084

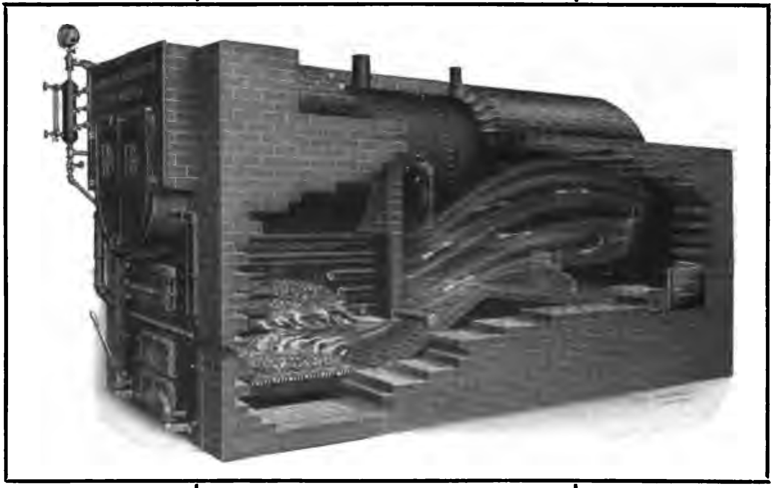
The Herbert Smokeless Downdraft Detachable Firebox

Is Made to Fit Any Standard Fire-tube or Water-tube Boiler — It is Absolutely Smokeless — Fully Guaranteed

Exhaustive tests have proven its supreme merit — the only smokeless furnace that increases the horse-power of boiler to which it is applied.

**Reasonable Original Cost — No Expensive Repairs
Durable Construction**

**Large Fuel Capacity
Commodius Combustion Chamber
Solid water-backed firebox—upper fire can be sliced without displacing fire-brick improved circulation**



Herbert Downdraft Detachable Firebox applied to standard horizontal tubular boiler

No excuse for smoke when the Herbert Detachable Firebox can be applied in 36 hours to any boiler any place.

Let us help you in all American Cities to eliminate destructive, extravagant, air-polluting smoke stacks.

Catalogs and working plans furnished upon request

Herbert Boiler Company Root and La Salle Streets **Chicago**

ALL STEEL CONSTRUCTION

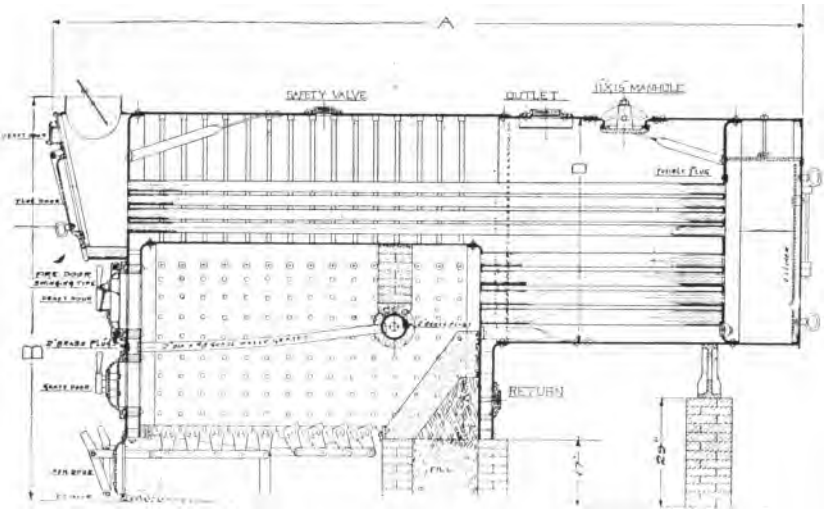
The "OIL CITY" Return Tubular Fire Box Boiler

—Built by—

Oil City Boiler Works

Oil City - Pa.

THE *"Oil City" Smokeless Boiler* is of the self-contained Return Tubular Fire Box Type, fitted with a water or down draft grate, for the abatement of smoke. It is designed to meet the requirements of laws adopted by many of the larger cities to eliminate the smoke nuisance. It is not an experiment, but a combination of the best features of the Locomotive and Horizontal Tubular boilers, types most universally developed in American boiler practice and known to the Engineering fraternity. In this combination we add the return flues of the Horizontal Tubular boilers to the internally fired Locomotive type, and eliminate from the former the brickwork setting, thus increasing the boiler efficiency by the heat absorbed by the brickwork setting. The down draft principle has been so thoroughly tried out and its merits proven so efficient as to place it entirely beyond the experimental stage.



LONGITUDINAL SECTION

PEERLESS

A SMOKELESS BOILER

Cut-away view showing position of the Water Grates the heating surfaces, the two combustion chambers, the lower grates, feeding and slicing doors, which with the other features shown, bring about smokeless results in burning soft coal.

In addition to these features, particular attention is called to the patented "S" arm water tubes, the feature of our regular cast-iron boilers, making them so efficient and economical, splitting up the waterways into small streams of water, making quick steam and responsive circulation, with the minimum amount of fuel. The most efficient and economical down-draft boiler on the market.

Peerless Heater Co., Pittsburgh, Pa.

"HAWKES BOILERS"

COMPLY WITH

SMOKE ORDINANCES OF ALL CITIES

WITHOUT

SPECIAL SMOKE ABATING DEVICES

THEY HAVE REVERBERATORY FURNACES

OUR CATALOG FULLY DESCRIBES

IS INTERESTING AND SHOWS ALL FEATURES. IN PURCHASING HAWKES BOILERS YOU ARE ASSURED OF FULL COMPLIANCE WITH

"ALL SMOKE ORDINANCES"

ALSO WATER TUBE, TUBULAR AND MARINE BOILERS

THE CASEY-HEDGES COMPANY

MARQUETTE BUILDING, CHICAGO PHONE CENTRAL 4031

Lowest in Height

Highest in Efficiency

Write for Catalogue

Kanawha Manufacturing Co.

Charleston, W. Va.

CHICAGO OFFICE:
175 West Jackson Boulevard

BERNHARD MAGAZINE-FEED SMOKELESS BOILER

Runs 12 to 18 hours without attention.

Burns any grade of soft coal smokelessly.

Magazine only 3 to 4 feet from floor.

Made in sizes from 500 to 17000 feet steam and water radiation.

IMPERIAL DOWN-DRAFT Smokeless Boilers for Steam and Hot Water Heating

FEATURES:

Extra Large Fire Box. Ample Combustion Chamber. Extra Large Feed Door. Ample Water Carrying Capacity—Insuring Steady Water Line in Steam Boilers. Brass Cleanout Plugs in Water Grate Sections. Special Smokeless Boiler Literature Mailed on Application.

UTICA HEATER CO. - Chicago, Ill. - Utica, N. Y.

CHICAGO OFFICE: 218 W. Kinzie Street

SERVICE—

Is what is obtained from the use of Thatcher Steam and Hot Water Boilers. Made in all sizes, single and double units.

Low Water Line.

Low in Height

Short Throw For Fuel

Long Combustion Travel

Large Grate Area Direct Heating Surface

Showing double unit boiler; either unit can be used independent of the other or both can be used as one complete unit. Write for catalog and information.

Thatcher Furnace Co.

New York Chicago

THE BROWNELL CO.

MANUFACTURERS

HIGH GRADE BOILERS
STEAM ENGINES
FEED WATER HEATERS

CHICAGO OFFICE
925 Monadnock Block

FACTORY—DAYTON, O.

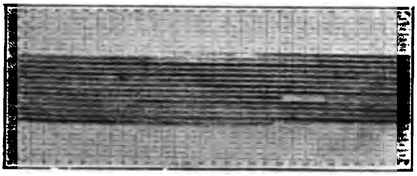


FIG. 1

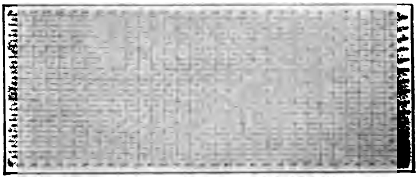


FIG. 2

HEINE BOILER

Eliminates The Smoke Nuisance

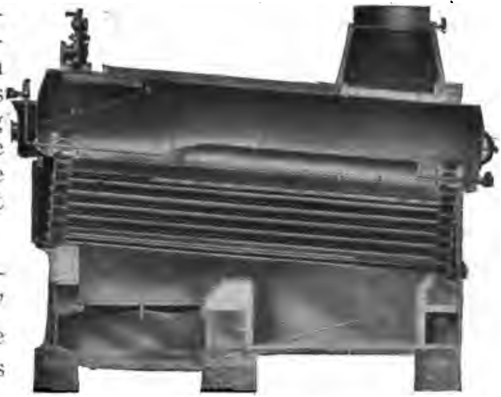
THE smoke charts shown in figures 1 and 2, reproduced from an article in POWER, October 13, 1914, by Osborne Monett, settle the question of boiler setting for smokeless combustion. They prove that the logical boiler for complete combustion and smokeless operation is the HEINE.

Smoke chart No. 1 was obtained with the old style chain grate setting. The boiler was baffled vertically, so that the tubes of the first pass were directly over the furnace and chilled the products of combustion. The coal burned was low grade Illinois screenings of 8902 B. T. U.

Smoke chart No. 2 was obtained when the same boiler was re-arranged with a setting 2 ft. higher, and with horizontal baffes, fire brick tiles being laid to encircle the bottom row of tubes and thus provide a large combustion chamber.

These facts should settle the question of proper furnace design in the mind of every engineer. Use horizontally baffled Heine boilers. In larger units the boiler is arranged with two long horizontal passes for the gases giving very low flue gas temperature, without excessive draft loss.

For further information send for "Boiler Logic," which discusses fully the requirements for smokeless combustion.



Standard Heine Boiler with Smokeless Setting for Bituminous Coals, Hand Fired

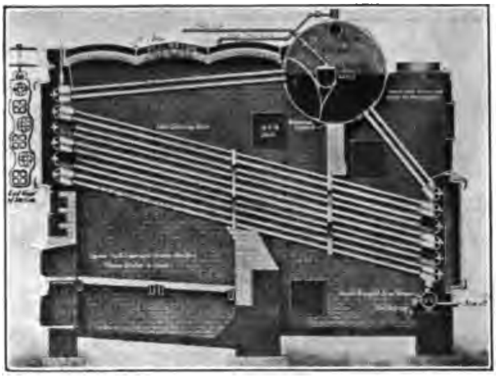
HEINE SAFETY BOILER CO.

2471 N. MARCUS AVE. - - - ST. LOUIS, MO.

SPRINGFIELD WATER TUBE BOILERS

SECTIONAL—SINUOUS HEADERS—NO BRACES
NO STAY BOLTS—NO BENT TUBES
OF ALL STEEL CONSTRUCTION

ONE Handhole for Each FOUR Tubes



Each Section Supported Individually

SPRINGFIELD BOILER & MFG. CO.

SPRINGFIELD, ILLINOIS
CHICAGO NEW YORK

TELEPHONE RANDOLPH 5998

J. G. O'NEIL

CONTRACTING ENGINEER

Scotch Internally Fired, Water Tube and Tubular Boilers

SOLE MANUFACTURER OF
UNITY EXHAUST HEAD

WESTERN MANAGER:
BUNDY STEAM SPECIALTIES
SPRINGFIELD BOILER & MFG. CO.

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ACME BOILER AND TANK CO.

Not Incorporated

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Tanks, Stacks, Breechings, Roofing Kettles and General Steel Plate Work

BOILER REPAIRING A SPECIALTY   OXY-ACETYLENE WELDING AND CUTTING

4738-40 WENTWORTH AVENUE - - CHICAGO

When in Doubt Call Upon

The

CONROY

Boiler and Tank Works

Manufacturers and Erecting Contractors

Builders of Boilers, Breeching, Stacks, Steel Tanks and Sheet Steel Work.

Repairing a Specialty **Inspections Made**
Estimates Furnished **Oxy-Acetylene Welding**

PHONE YARDS 5606

Address, 2213-15 W. 47th St., Chicago, Ill.

Eleventh Annual Convention

of the

SMOKE PREVENTION ASSOCIATION

ST. LOUIS, MISSOURI

September, 27-28-29, 1916

Headquarters—Planters Hotel

Among Cincinnati plants which have been converted to smoke elimination and whose success in its realization is conspicuous, two stand forth—the Fleischmann Company and the Procter & Gamble Co. Both are TAYLOR stokered plants.

It is not strange to find these two leading Cincinnati concerns eliminating their smoke via the stoker which in Cleveland has performed a like service for the Mechanical Rubber Company and the Beckman Company; in Akron for the Northern Ohio Traction and Light Company; in Detroit for the Detroit Edison; in the Pittsburgh district for National Tube Company, Jones and Laughlin, Pressed Steel Car Company and Republic Iron and Steel Company; in Washington for the Potomac Electric; in Baltimore for the Consolidated Gas, Electric Light and Power Company; in Boston for the Boston Elevated, Boston Woven House and Rubber Company, Commonwealth Ice and Cold Storage Company; in—but there is no space here to give even one or two of the many plants in each great center of population that have not only eliminated their smoke, but increased capacity, lowered labor cost, minimized maintenance, with this supreme combustion system—the TAYLOR Stoker.

Why not ask our man to call on you? And drop a line for our latest catalog.

AMERICAN ENGINEERING CO.

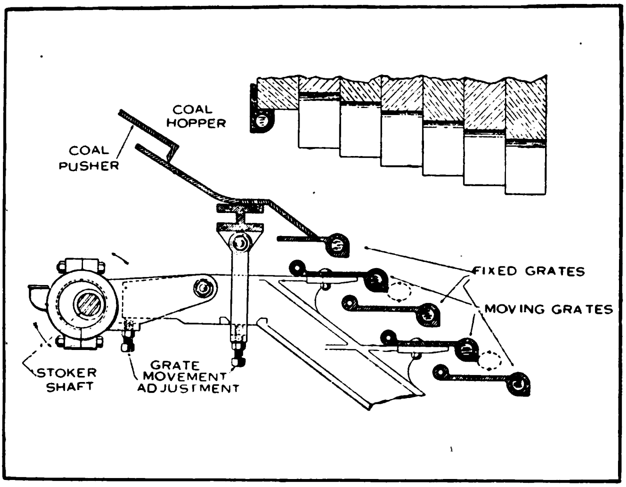
PHILADELPHIA

A SURE CURE FOR SMOKING

℞ “CO_2X—FULTON STOKER”

“IT’S WATER COOLED”

WHEN A LONG BLACK STREAM
GOES ROLLING FROM THE STACK
THERE’S A BUNCH OF LONG GREEN
GOING OUT THAT WON’T COME BACK



“THE MOVEMENT HAS A MEANING”

NO SMOKING
SIFTING
REPAIRING
REGRETTING **“CO”**

The James A. Brady Foundry Co.

35th Street and Ashland Ave., Chicago, Ill.

STOKERS—A Type and Size for Every Service—ASK US

“COX-FULTON”—WATER COOLED
“SIMPLEX”—TRAVELING GRATE
“MONARCH”—HIGH DUTY, (Forced Draft)

Before Installing Jones Stokers

SMOKE

is a sign of improper furnace conditions

JONES STOKERS

are installed under a positive smoke abatement warranty. They will abate smoke, and save from 10% to 30% of the fuel.

The Under-Feed Stoker Co.
of America

General Offices: Harris Trust Bldg., Chicago

New York **Minneapolis** **Toledo** **Salt Lake City**
Pittsburgh **Philadelphia** **Kansas City** **Buffalo**
Cincinnati **Detroit** **Boston** **Denver**

After Installing Jones Stokers

The Choice of a Stoker

Always Narrows
Down to a Study of
Plant Requirements

Westinghouse Electric & Mfg. Co.
East Pittsburgh, Pa.

Build
These Three Types—

Underfeed
Overfeed
Chain Grate

Burke Furnace Company

223 West Austin Avenue - - - Chicago, Illinois

Sole Licensees in United States and Canada

Burns Cheap Soft Coal Without Smoke

Entirely Under the Boiler

No Power Needed for It's Operation

Patented 1915

Easily and Quickly Installed Under New or Old Boilers

No Brick Arches to Maintain

Soon Pays for Itself in Fuel Saving

Chicago No. 8 Smokeless Setting

for Power and Heating Boilers

"BURKE" Gravity-Feed and Semi-Automatic Suitable for all Kinds of Boilers

Over 1000 "BURKE" SMOKELESS FURNACES in Daily Service onAll Kinds of Boilers

BURKE SMOKELESS FUEL-SAVING FURNACES

COMPLY WITH CITY SMOKE ORDINANCES

RITTER IMPROVED "S. and S." STOKERS

Insure LOW FUEL COST and PREVENT SMOKE

Write

Emil W. Ritter Co.

223 W. Austin Ave.

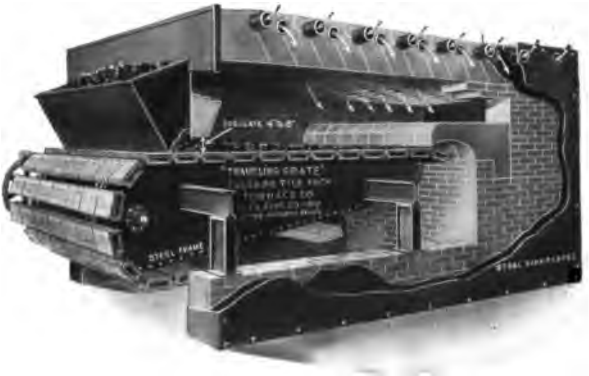
Chicago - Illinois

Chicago Tile Arch Furnace Co.

NOT INC.

321-323 West Austin Avenue

Manufacturers of Hand Fired, Gravity-Feed and Traveling Grate Furnaces



The accompanying illustration shows a traveling grate that has many new and commendable mechanical features. The side frames are supported by beams and stirrups independent of the furnace side walls. The upper run of grates is supported on smooth level continuous tracks securely riveted to side frames, and there in turn bear on the lower or return track which is inclined, returning grate to front mechanism, which is driven by worm gear, and may be belted to countershaft or driven direct. The front and only sprocket is keyed on front shaft. The method of attaching the grate bars is so ample that they may be renewed, while the stoker is in operation; all parts are interchangeable and automatically clean themselves. The bars are used in small units, thus reducing the tendency to warp, and cost of repairs. The ignition arch presents a flat top with special designed tile, constructed so that after it is heated with burning fuel the volatile gases are at the point of ignition mixed with air at a very high temperature, and turned into heat units before escaping from the arch, thus adding to the efficiency of the fuel and preventing the formation of smoke.

Chicago Tile Arch Furnace Co.

Mr. Smoke Inspector:

A McMillan Semi-Automatic Gravity-Feed Smokeless Furnace will help you to make a Clean City. INSTALLED ANYWHERE.

We manufacture the McMillan Semi-Automatic Gravity-Feed, McMillan Plain Gravity-Feed Smokeless Furnaces, McMillan Extension Type Hand-Fired, McMillan Direct Type Hand Fired Furnaces.

Write Us for Cuts and Information.

"IT'S REALLY SMOKELESS"

Steel Encased Fuel Saving Furnace

James McMillan and Co.

Exclusive Makers
33 North Market St., CHICAGO, ILL
Branch Offices—
Principal Cities in the United States

Important Features
OF
Detroit Stokers

FUEL ECONOMY—Saving in fuel costs from 10-20%.

LABOR SAVING—Labor costs reduced 50-75%.

FLEXIBILITY—Easily handles variable loads.

CAPACITY—Ability to increase capacity with high efficiency.

SMOKELESSNESS—Proper method of combustion resulting in clean stacks.

Before and After Installing Detroit Stokers

Detroit Stoker Company
DETROIT, U. S, A.

The Model Automatic Smokeless Furnace

Highest Efficiency and Capacity.
Requires Only Natural Draft.
Cleans Automatically. Have a
a clean stack with a clear profit.

Catalogue on Request.

The American Foundry & Casting Co.
DAYTON - - - - - - OHIO

Green Chain Grate Stokers

Smokeless
Automatic
Labor Saving

Green Engineering Co.
EAST CHICAGO, IND.

Geco Steam Jet Ash Conveyors
Geco Pressure Waterbacks
Geco Flat Ignition Arches

CATALOGS SENT ON APPLICATION

ILLINOIS STOKER CO.

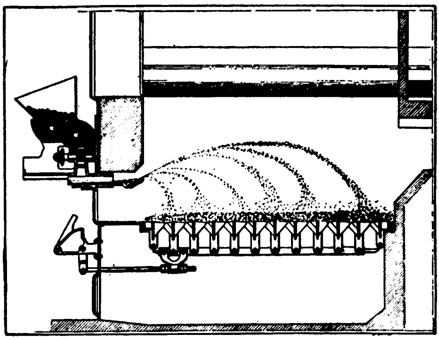
ALTON, ILL.

MANUFACTURERS OF

NATURAL AND FORCED DRAFT CHAIN GRATE STOKERS

KO-SHOVEL STOKING MACHINES

Fire "Light" Charges of Coal "Often" by Spreading Them Over Entire Grate Area—The SMOKELESS Method.



KO-SHOVEL Method of Supplying Coal to Furnace Over the Fire with Fire Doors Closed. Please Note that Machines are Directly Over Fire Doors.

Durable
Simple
Inexpensive

The "Ford" of the Stoker World

No Possibility of a Shut-Down

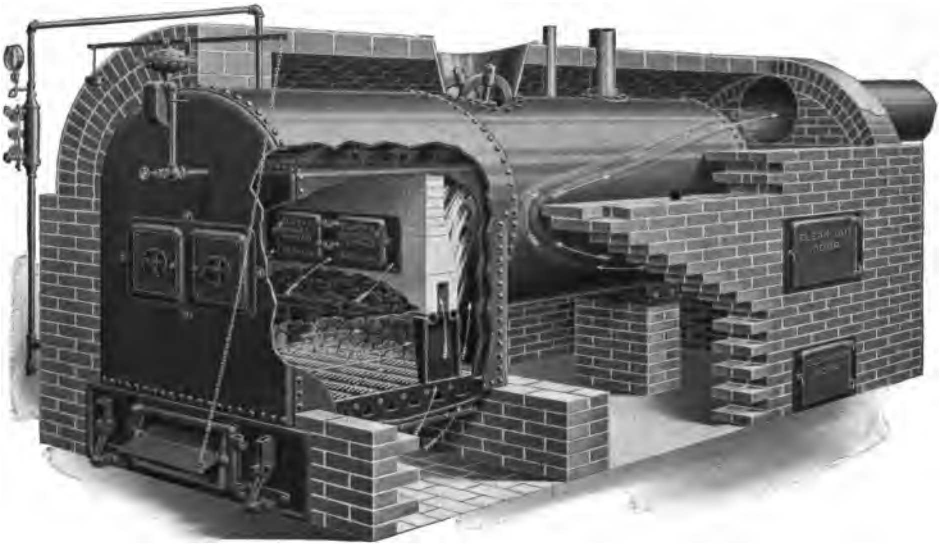
Automatic

For Estimates of Cost of Equipment Write

GOETZ CO. - Manufacturers - CHICAGO

403 MONADNOCK BUILDING

We Do Not Manufacture a Smokeless Boiler, But We Do Make a BOILER SMOKELESS



OUR CLAIMS

The old way requires firing every two to three hours.

OUR METHOD requires firing but every SIX TO EIGHT HOURS.

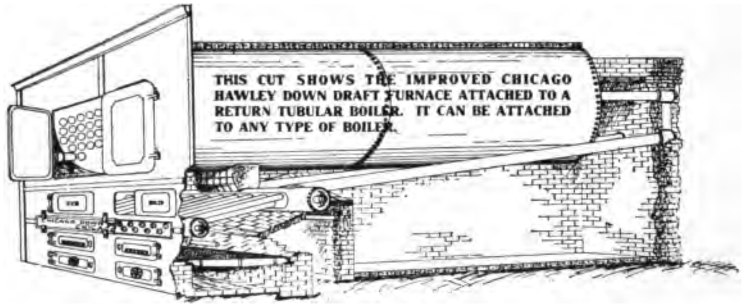
The old way results in NO heat with banked fires at night.

OUR METHOD RESULTS IN STEADY HEAT ALL NIGHT WITH A BANKED FIRE.

OUR FURNACE SAVES 30% of fuel bill, and any fair grade of soft coal can be burned.

We substantiate our claims with a GUARANTEE.

EUREKA SMOKELESS FURNACE CO.
Room 1401, 105 So. La Salle Street - - CHICAGO


THIS CUT SHOWS THE IMPROVED CHICAGO HAWLEY DOWN DRAFT FURNACE ATTACHED TO A RETURN TUBULAR BOILER. IT CAN BE ATTACHED TO ANY TYPE OF BOILER.

Smoke Prevention

By the Old Reliable Method

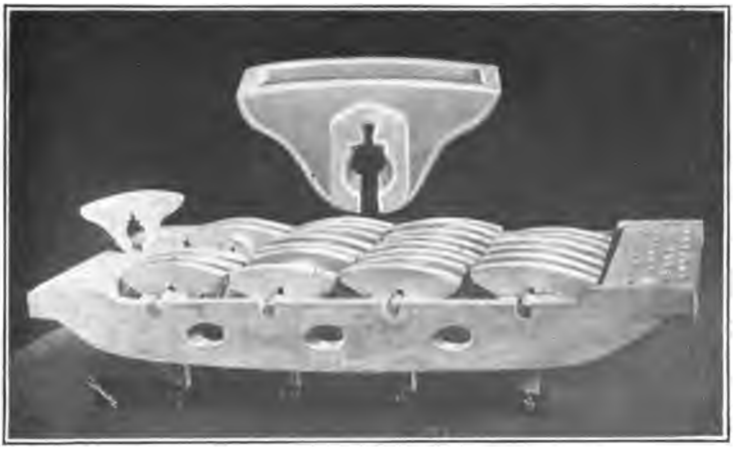
IT is an undisputed fact throughout the country that the Down Draft System of burning soft coal, under different types of boilers, is the most reliable method for preventing smoke and getting high efficiency from the coal you burn under your boiler for generating steam, in either High or Low pressure plants. So well has this fact been established, that a great many firms who manufacture heating boilers have adapted this system to their particular type of boiler, and some of them claim a saving from 10 to 50 per cent, in burning the low grade soft coals, which no doubt is true. *With our 24 years' experience in* the manufacturing and operating of Down Draft Furnaces for the different standard makes of boilers, such as Return Tubular, Scotch Marine and water tube boilers, the buyer may be assured that he is not experimenting, when he purchases a Down Draft Furnace from our Company, for any standard make of boiler, as we use the best material for either High or Low pressure furnaces that can be purchased. *We guarantee all workmanship and design of same.* It will be a pleasure for us to furnish you with booklet giving full information regarding our furnace upon request.

CHICAGO DOWN DRAFT FURNACE CO.
INC.
MANUFACTURERS
OF THE IMPROVED
CHICAGO HAWLEY DOWN DRAFT FURNACE

115-117 South Clinton Street **CHICAGO**

Hansell Fire Box Grate

THE RESULT OF MANY YEARS SCIENTIFIC EXPERIMENT
BY A PRACTICAL ENGINEER



NO
- DUMPING OF FIRE
- LOSS OF STEAM
- STOPPING OF MACHINERY
- CLINKER TROUBLE
- GETTING INSIDE THE FURNACE
- DROPPING DOWN OF GRATES

IS ADAPTABLE TO ANY STATIONARY OR LOCOMOTIVE BOILER. : : : : : : : : : : : :

WOOD, SOFT, HARD AND STEAM COAL CAN BE USED. : : : : :

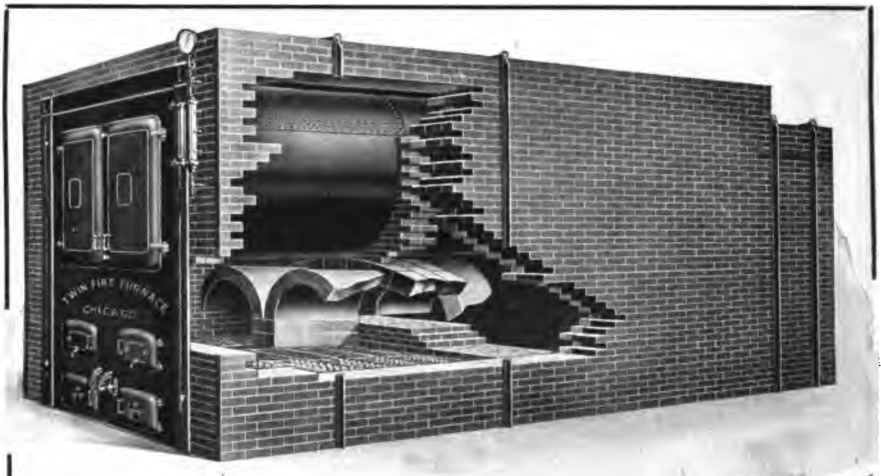
CONSUMES LESS FUEL THAN ANY OTHER GRATE ON THE MARKET AND ON ACCOUNT OF ITS LARGE AIR AREA EFFECTS A NEARLY PERFECT COMBUSTION, THEREBY REDUCING SMOKE TO A MINIMUM. : : : : : : : :

58% AIR SPACE THROUGH GRATE

FOR FULL PARTICULARS AND PRICES APPLY TO

HANSELL GRATE COMPANY

RAILWAY EXCHANGE BLDG. :–: CHICAGO



SMOKELESS
TWIN FIRE FURNACE
AND
TWENTIETH CENTURY ROCKING GRATES
FOR POWER AND HEATING PLANTS
MANUFACTURED BY
Water Arch Furnace Company
1253 FIRST NATIONAL BANK BLDG., CHICAGO
INCORPORATED 1898

WE KNOW THE READERS OF THIS REPORT ARE INTERESTED IN SMOKE PREVENTION AND CONSEQUENT FUEL SAVING.

WE HAVE HAD 18 YEARS EXPERIENCE IN THIS FIELD AND STAND ON OUR RECORD OF SUCCESSFUL PLANTS IN CHICAGO AND THROUGHOUT THE MIDDLE WEST, IN OFFICE BUILDINGS, HOTELS, HOSPITALS, SCHOOLS, INSTITUTIONS, FACTORIES AND PUBLIC POWER PLANTS.

OUR ENGINEERING DEPARTMENT
IS AT YOUR SERVICE.

Improved Combustion Company

Peoples Gas Building - - Chicago

Forced Draft System *for* Hand Fired Furnaces

We Will Solve Your

SMOKE PROBLEMS

AND REDUCE YOUR FUEL BILLS

This System Successfully
Burns Low Grade Fuels

RESULTS GUARANTEED

No Gas Washer or Smoke Consumer

is necessary with the Kerner
"Built-in-the-Chimney" Incinerator

At last an Incinerator for the home and apartment has been perfected which works without odors and without operating cost—efficiently, simply and positively.

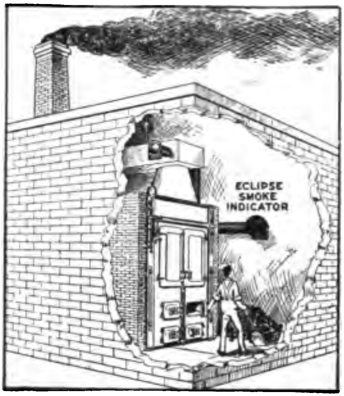
A small receiving door in the kitchen—an incinerating chamber built in the base of the chimney—that is the Kerner Incinerator. Into the receiving door go garbage, tin cans, rags, broken crockery—in fact, everything you do not want. The fire is lighted and that is the end of it.

Oxygen is fed to the gases formed at the top of the burning refuse, insuring complete combustion without odors.

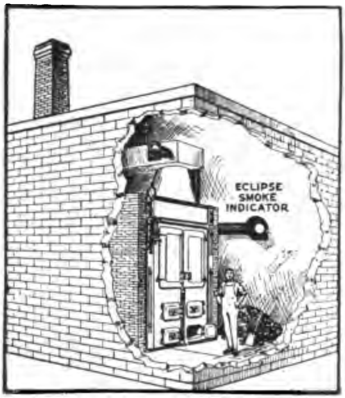
It is today saving many cities thousands of dollars. Costly municipal garbage collection and destruction is eliminated in Kernertown.

KERNER INCINERATOR COMPANY
Milwaukee, Wis.
BRANCHES IN PRINCIPAL CITIES

QUIT DODGING THE SMOKE INSPECTOR



The Eclipse Smoke Indicator, Indicating a Smoking Stack



The Eclipse Smoke Indicator with Bright Moon, Indicating a Clear Stack

You will have smoke until the fireman is given a gage of some kind to measure the smoke he is making. The

Eclipse Smoke Indicator

is such a gage, and it is the only smoke gage on the market. The ECLIPSE SMOKE INDICATOR is an arrangement of an electric light, a tube, mirrors and a hooded screen. When thereis no smoke, thescreen shows a bright, "Full Moon." When thereis dense smoke the "Moon" passes into total eclipse. All of the gradations of smoke are shown by gradations of color on the "Moon." When the fireman looks at the "Moon" of the Eclipse Smoke Indicator he virtually sees the top of the stack. With his eye on the "Moon," and his hand on the damper, the fireman can get the exact draft necessary to wipe out the smoke. He will know the instant that he has this draft, and thereafter he will know what draft to use without looking at the "Moon."

By counting the number of shovels of coal fired, and watching the "Moon" he can learn exactly how much coal he may throw into the furnace at one firing.

If necessary to "crack" the fire door after throwing in the coal, the "Moon" will tell him how wide to "crack" the door, and how long to keep it cracked.

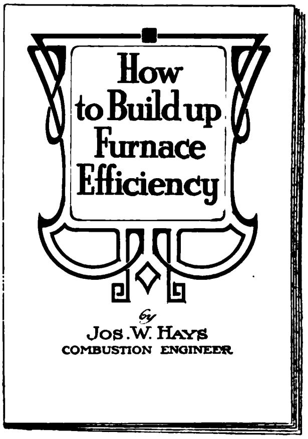
Smoke means TROUBLE WITH THE SMOKE INSPECTOR. Smoke means that you are a NUISANCE to your NEIGHBOR and a NUISANCE to YOURSELF. *Write for pamphlet "Fumifugina."*

ALL ABOUT COMBUSTION

To be efficient Smoke Inspectors or Engineers you must be thoroly posted on *combustion* and best boiler room practice. Read HOW TO BUILD UP FURNACE EFFICIENCY—by Jos. W. Hays—126 pages—Price $1.00.

COMBUSTION AND SMOKELESS FURNACES—by Jos. W. Hays—118 pages—Price $2.00.

Send in your order and write for our complete catalog on *"The Simonds Fuel Economy Lines"* on Gas analyzers, Draft gages, CO2 Recorders, Soot Cleaners, Scale Cleaners and Smoke Indicators.

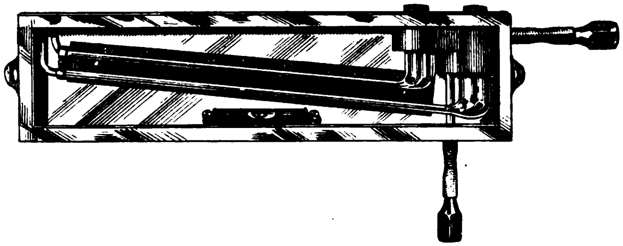


How to Build up Furnace Efficiency

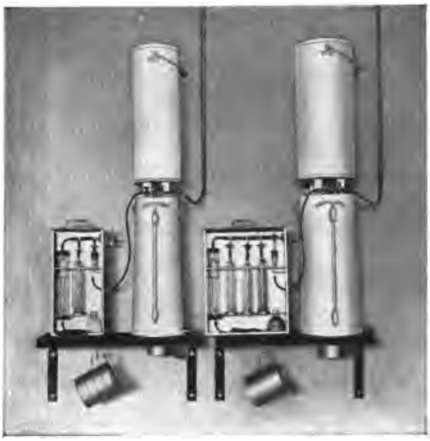
By Jos. W. Hays
Combustion Engineer

G. L. Simonds & Co.

511 Gaff Bldg. Chicago, Ill.



Defender Duplex Draft Gauge



Defender
Model C—12 and 24 hour
Gas Collector

Defender
Single Chamber
(Orsat)
Gas Analyser

Defender Automatic Regulator Co.

Oriel Bldg. - St. Louis, Mo.

Manufacturers of Nine Types of Draft Gauges, Four Types of Gas Analysis Instruments for CO_2, O and CO. Four Types of Gas Collectors, Portable Boiler Room Test Outfits and other Special Boiler Room Instruments

Defender
Flue
Gas Thermometer

Loedige Quick Acting Blower Valves
Stop Black Smoke on Locomotives

"Before and Five Seconds After Using"

Tests made for the General Managers Association at the Altoona Testing Plant of the Pennsylvania Railroad demonstrated the NECESSITY of a "QUICK ACTING BLOWER VALVE, easily operated, capable of giving Reasonable Graduations in Pressure." See proccedings A. R. M. M. Assn., Year 1913, Pages 352 and 366.

SARGENT COMPANY **CHICAGO**

Osborn Monnett

AND

H. L. Whitelaw

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